Arming The Fleet

Supporting Naval Aviation And Warfighter Requirements Since 1943

– Highlights –

NAVAIR

WEAPONS DIVISION

CHINA LAKE • POINT MUGU

CALIFORNIA

CONTENTS

OVERVIEW

The Naval Air Systems Command (NAVAIR) delivers weapon systems to warriors for Navy and Marine Corps missions. Products and services include fixed and rotary wing aircraft, avionics, air- and surface-launched weapons, electronic warfare systems, cruise missiles, unmanned aerial vehicles, launch and arresting gear, and training systems.

NAVAIR encompasses eight sites across the country. The Aircraft Division has sites at Patuxent River, Maryland; Lakehurst, New Jersey; and Orlando, Florida. NAVAIR depots are located at North Island, California; Jacksonville, Florida; and Cherry Point, North Carolina. The Weapons Division includes sites at China Lake and Point Mugu, California. The entire NAVAIR organization has made significant contributions to the Fleet by providing total life cycle support: research, design, development, and engineering; acquisition; test and evaluation; repair and modification; and in-service engineering and logistics support. Many NAVAIR publications have documented significant contributions to the Fleet in support of naval aviation and warfighter requirements.

This document, produced by the NAVAIR Weapons Division, focuses specifically on the weapons and systems Research, Development, Test and Evaluation (RDT&E) contributions made at China Lake and Point Mugu since 1943.

During every United States military crises since World War II (WWII), RDT&E work at China Lake and Point Mugu has played a significant role: developing and testing weapons and systems that work.

Recognized Expertise. Through the years, WD has earned a national and international reputation for technical expertise in numerous areas.

Technical Expertise

- Test and evaluation
- Technology transfer
- Modeling and simulation
- Image and signal processing
- Laser and optical components
- Electro-optics/infrared systems
- Fuzing components and devices
- Interoperability of warfare systems
- Energetic materials and subsystems
- Advanced weapons and guided missiles
- Radar systems, including synthetic aperture
- Complex weapon system/software integration

Firsts. The Weapons Division provides direct Fleet support for naval aviation and is recognized for a number of significant "firsts" in weapon technology development. In addition, WD has extensive experience in developing, perfecting, and testing military components and subsystems that also have direct application to space missions. Although work for other government agencies represents only a very small fraction of the total workload, the Division is occasionally called upon by NASA to lend expertise to projects of national importance. Lessons learned from joint projects help WD find solutions to naval aviation problems. China Lake and Point Mugu are recognized for several space related and earlier undersea "firsts."

Firsts

- Air-to-air guided missile ever used in combat–Sidewinder
- X-ray video system to see inside rocket motors while firing
- To develop and test the concept for the Polaris missile
- U.S. precision-guided air-to-surface weapon–Walleye
- U.S. manned submersible to descend 2,000 feet
- Technology to photograph the back side of the moon
- Mars and Lunar Landings–subsystem RDT&E
- Atomic bombs–non-nuclear components
- Reprogrammable self-protection jammer
- Successful antiradar missile–Shrike
- Real-time night display of targets
- U.S. satellite launch–NOTSNIK
- Plastic-bonded explosives
- U.S. aircraft rockets

Guided Missile Development. China Lake has made significant contributions to every aspect of guided missile technology and development. WD expertise has had a significant impact in the arsenal of U.S. air-, surface-, and subsurface-launched weapons that cover virtually every threat, from enemy aircraft, to surface and sub-surface combatants, to radar systems, to hardened ground targets.

A Unique Place For Unencroached RDT&E Of Weapons And Weapons Related Technology. WD is home to the largest and most diverse test range in the world, with a wide variety of features mountains, ocean, deep-water ports, protected islands, deserts, canyons, and forests in close proximity and all highly instrumented. The Land Ranges are larger than the state of Rhode Island, and the Sea Range is the Navy's largest test and evaluation (T&E) facility. The Division has outstanding weather for testing and conducts more than 3,000 test events each year. WD is a billion dollar per year operation with more than 6,000 employees and 40 major facilities, many of which are not duplicated anywhere else in the world.

Since the 1940s, China Lake and Point Mugu have earned a strong reputation as pioneers in experimentation. Through the years WD has contributed to more than 50 major weapon systems, including the Sidewinder missile, Joint Standoff Weapon (JSOW), and Joint Direct Attack Munition (JDAM), and the Division is now working on weapons of the future.

WD Location. China Lake is located about 150 miles northeast of Los Angeles on the western edge of California's Mojave Desert. Point Mugu is located on the Pacific Coast about 65 miles northwest of downtown Los Angeles, near the cities of Camarillo and Oxnard.

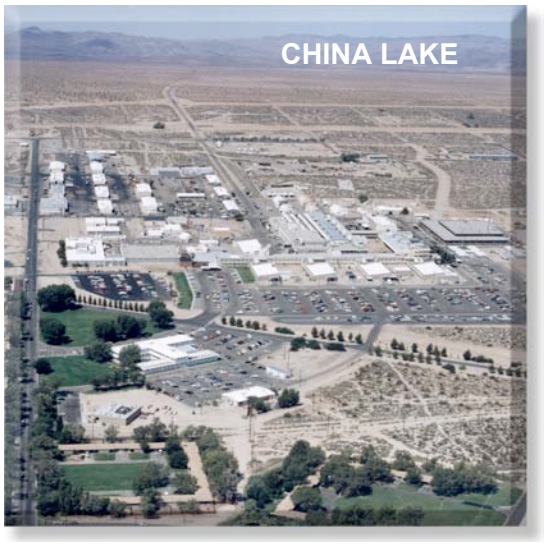
Ranked Highest In Military Value. During 1995, the top three naval technical activities were all NAVAIR sites. Secretary of the Navy John Dalton, on June 14, stated: "…China Lake and Point Mugu [rate] number 1 and 2 in military value among all Navy activities…"

Military value includes physical and community assets and environmental and human resource factors. WD has advanced physical facilities, strong community support, low encroachment, excellent human resources, and broad mission capabilities. For example, 70 Technical Centers across the Navy were asked to carefully document their level of work involvement in 34 specific common support functions. Final results showed that no Center was involved in more than eight functions—except China Lake, which had significant documented work in 23 different functions. Point Mugu was involved in eight.

Evolution Of Modern Weapons. In WWII, China Lake and Point Mugu contributed extensively to several product lines that are still in use and being upgraded today, including aircraft rockets, antisubmarine weapons, guided missiles, and general purpose bombs. During the Korean Conflict, folding-fin aircraft rockets (FFARs), specialized antitank weapons, and fire-control systems were developed. By the end of the Vietnam War, efforts also encompassed laser-guided weapons and other "smart bombs," air-to-air and air-to-surface guided missiles, dispenser munitions, antiradar missiles, fuel-air explosives (FAEs), advanced antiship weapons, ship-launched guided missiles and projectiles, strategic weapons, aircraft guns, and swimmer/SEAL (Sea-Air-Land) weapons. Later, improvements were made in aircraft electronic warfare, avionics, and software, and by Operation Desert Shield/Storm, China Lake and Point Mugu technology had made a significant impact on nearly every aircraft and weapon system used, including Sidewinder, High-Speed Antiradiation Missile (HARM), Tomahawk, Rockeye, Sparrow, and Harpoon—along with the avionics to integrate and operate the weapons. The Bosnian war made use of the Advanced Medium-Range Air-to-Air Missile (AMRAAM), cluster bomb unit (CBU)-87, and CBU-99. JSOW and JDAM made their debut in Desert Fox. WD contributed significantly to these weapons. In Afghanistan and Operation Iraqi Freedom, U.S. and allied forces have relied heavily on many of these weapons and technologies. And Sidewinder still remains the world's premiere air-to-air missile.

WD Contributed To More Than 50 Major Fleet Weapon Systems. In addition to designing new weapons, WD is also upgrading and transforming existing weapons. Through the years, WD and its predecessor organizations developed and contributed to more than 50 major weapon systems and pioneered technologies that support the Fleet today.

HISTORY



China Lake. In the midst of World War II, the Navy established China Lake as the Naval Ordnance Test Station (NOTS) for testing and evaluating rockets being developed by the California Institute of Technology (Caltech). The formal mission statement for NOTS in 1943 identified "research, development and test of weapons" as the Station's primary purpose. This mission remains today. The first weapons included rockets and early missiles such as Mighty Mouse, Zuni, Sidewinder, and Shrike. In the 1950s, NOTS scientists and engineers developed the air intercept missile (AIM)-9 Sidewinder air-to-air missile, which has become the world's most used and most copied air-to-air missile. In 1967, China Lake combined with the Naval Ordnance Laboratory at Corona to form the newly created Naval Weapons Center (NWC). In 1979, the National Parachute Test Range (NPTR) at El Centro, California, also merged with NWC. In 1992, NWC China Lake joined the NAVAIR units at Point Mugu, California, and White Sands in Albuquerque, New Mexico, to become part of the Naval Air Warfare Center Weapons Division (NAWCWD). Today, WD is headquartered at China

Lake and is a tenant of the Navy Region Southwest. On May 12, 2000, the U.S. Naval Museum of Armament and Technology was officially established at China Lake when the Secretary of the Navy signed the establishing memo, culminating a 10-year effort. "China Lake's notable accomplishments and famous desert culture have created an esprit de corps perhaps unequalled in the Navy's far-flung organization," wrote Dr. William S. Dudley, director of naval history, in a message to command. The Museum contains one of the finest publicly accessible collections of tactical air weaponry and technology anywhere. The display collection ranges from WWII rockets to cutting-edge guided missiles and includes familiar items like Sidewinder, Shrike and Tomahawk alongside weapon systems that can be seen nowhere else—Agile, ACIMD, Bulldog and the Advanced Bomb Family (to name but a few).

Point Mugu. The first Navy presence at Point Mugu occurred in 1946 when Seabees from Port Hueneme put down a Marsden Mat runway as the first airstrip. That same year, Point Mugu became the Naval Air Missile Test Center (NAMTC), the U.S. Navy's first instrumented missile-test sea range. NAMTC developed and tested missiles and drones, including the Gorgon, Gargoyle, Lark, and Little Joe. The Pacific Missile Range (PMR), headquartered at Point Mugu, was established in 1958. In 1959, NAMTC became the Naval Missile Center (NMC). Point Mugu, already home to the F-14 Tomcat System Integration Test Station, became host to the Software Support Activity for the Tomcat in 1971. As the Harpoon, Tomahawk, Trident, and Standard Missile were under test in 1975, the Navy merged PMR and NMC into the Pacific Missile Test Center (PMTC). In 1992, PMTC, NWC China Lake, and NAVAIR units at White Sands and Albuquerque, New Mexico, combined to form the NAWCWD. On November 14, 2003, the Naval Base Ventura County at Point Mugu was formally named an American Institute of Aeronautics and Astronautics (AIAA) historic site because of its involvement in the development and testing of guided missiles. The institute designation placed it in the company of 20 other historic spots, including Kitty Hawk, N.C.; Dutch Flats, the San Diego airport where Charles Lindbergh's Spirit of St. Louis was tested; and the Air Force Flight Test Center at Edwards Air Force Base, home of legendary test pilots and fledgling astronauts; and the Pasadena plant site where scientists for Aerojet Engineering invented rocket fuel in the 1940s.

PEOPLE, RANGES, AND LABORATORIES

Dynamic Work Force. Today, more than 6,000 unique individuals continue the WD tradition. Close to 4,000 federal employees work side-by-side with more than 2,000 contractors, and military personnel, and 74% of the work force are in RDT&E competencies. WD is an efficient organization. Scientists, engineers, physicists, and mathematicians work on complex issues vital to national defense. Since 1959, more than 1,500 patents have been issued at WD. Some inventors hold more than 20 patents.

Innovative Management. July 2002 marked the 21st anniversary of the Navy's Joint Personnel Demonstration Project, which supports pay-for-performance rather than longevity. China Lake was one of two sites to test this new approach to personnel management. The Demo project has been closely scrutinized and has been so successful that Congress extended it twice and then permanently adopted it. The Demo now serves as a model for 16 other federal personnel projects.

> *"I think we have some of the answers to that, Mr. Chairman, in the experiments that have already been conducted, thanks to the discretion the Congress has given us in the past. And I think that record shows that at key installations like China Lake where we have, perhaps, one of the best civilian work forces any country could ever have—private sector or government. It's produced some of the most remarkable technological breakthroughs. I think that flexibility in management has improved the capability of that civilian work force—has allowed us to keep the very best people around."*
>
> —Paul Wolfowitz, Undersecretary of Defense
> From his testimony before the HASC during a hearing on 1 May 2003, on the Defense Department's proposed legislation to revamp the personnel system.

Enormous Ranges. WD's land, sea, and airspace are unique natural assets and are used for training and T&E. WD encompasses more than 1.1 million acres. The Land Range at China Lake is the Navy's largest single land holding, with 38% of all Navy land worldwide and 85% of the Navy's RDT&E land. The R-2508 restricted airspace, 12% of California's total airspace, includes more than 17,000 square miles over land. The Sea Range at Point Mugu includes 36,000 square miles of ocean (expandable to 196,000 square miles, from Big Sur south to the U.S./Mexico border). The R-2508 is jointly managed by the Navy (China Lake), the Air Force (Edwards Air Force Base (AFB)), and the Army (Fort Irwin).

Ranges are interconnected. For example, a unique FAA-approved restricted corridor (IR-200) connects the Sea Range with the Land Range to the north. This allows the launch of long-range Tomahawk cruise missiles from the Sea Range to targets on the Land Range, thereby allowing the Navy to test

all operational aspects of the weapon system. Missiles are continuously monitored and tracked. They contain inert warheads, and chase planes can take control at any time.

Clear Weather For Testing. Both the Point Mugu Sea Range and China Lake Land Range airfields consistently enjoy great flying weather. Point Mugu is VMC (visual meteorological conditions) 85% of the time and China Lake is VMC 99.5% of the time—in other words, more than 360 clear days per year. Even Palm Springs, California, cannot match WD's meteorological statistics.

Facilities. WD has more than 40 major facilities, including three airfields, with a replacement value of close to $3 billion. More than 2,000 buildings encompass six million square feet. Many highly specialized facilities are not duplicated anywhere else.

The Sea Range off the coast of Point Mugu is the largest and most heavily instrumented sea and air range in the U.S. The Range Operations Center is capable of hosting and monitoring complex full battle group Fleet exercises involving aircraft, surface ships, and submarines. San Nicolas Island (SNI), 60 miles offshore, is used for littoral warfare training, including theater warfare exercises. SNI includes launching facilities and a 10,000-foot runway. At Point Mugu the Radar Reflectivity Laboratory (RRL) is the Navy's largest indoor radar reflectivity chamber, designated as a national asset. For more than 35 years, the RRL has helped determine what a target looks like to radar. The F-14 Weapons System Integration Laboratory supports software and avionics integration for the F-14A Tomcat aircraft and Phoenix missile systems. The Missile Systems Evaluation Laboratory is a $45-million facility with 123,000 square feet of special-purpose laboratories. This targets complex is the only facility to provide full life-cycle support for all Navy aerial and surface targets. The Surface Craft Division at Port Hueneme operates target boats and hulks and provides range surveillance and target recovery. Point Mugu's electronic warfare (EW) capability is a core area of expertise and supports the electronic attack (EA)-6B, the stand-off jammer aircraft for the Navy and the Air Force. It is the only dedicated tactical EW platform in the U.S. inventory.

At China Lake, the fighter/attack (F/A)-18 Advanced Weapons Laboratory (AWL) and the AV-8B AWL rank in the top 9% of the world's software developers. The Propulsion Laboratory is the Navy's one-stop shop for R&D of missile propulsion, ordnance, and fuzing. The Integrated Battlespace Arena (IBAR) includes nine modeling and simulation (M&S) laboratories, with secure links worldwide. The Missile Engagement Simulation Arena (MESA) hangs full-size jets like puppets, weighing up to 25,000 pounds, when testing missile fuzes. It is the only facility of its kind. The Skytop facility tests Trident and other massive rocket motors with up to one million pounds thrust as well as rocket motors that produce only ounces of thrust. The Electronic Combat Range (ECR) realistically simulates combat threats. China Lake's Geothermal Plant turns a natural asset, volcanic steam, into usable electricity that helps power the base. And the Etcheron Valley Range, with mountains high in iron content, provides a perfect veil for testing high-powered GPS jamming; the Supersonic Naval Ordnance Research Track (SNORT) is a four-mile-long, dual-rail track, capable of propelling test items up to four times the speed of sound; and the new Live Fire Survivability Complex, when completed, will be the largest facility of its kind in the country.

Tenant Commands

Developmental Test And Evaluation

Air Test And Evaluation Squadrons (VX-30) At Point Mugu And (VX-31) At China Lake operate under the command of the Weapons Division and perform aircraft and weapons developmental testing and provide aircraft, aviators, and aircrew to support the RDT&E mission on NAVAIR's Sea and Land Test Ranges on the West Coast. They fly the F/A-18 Hornet, F-14 Tomcat, EA-6B Prowler, AV-8B Harrier, attack helicopter (AH)-1 Cobra, and HH-1 Huey in support of weapon systems integration and sustainment. They also fly the NP-3D Orion, C-130 Hercules, T-39 Saberliner, and QF-4 Phantom in support of "systems under test" on NAVAIR's test ranges; pilots log more than 10,000 hours of testing and training missions annually.

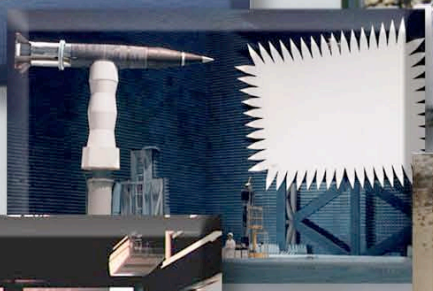
Operational Test And Evaluation

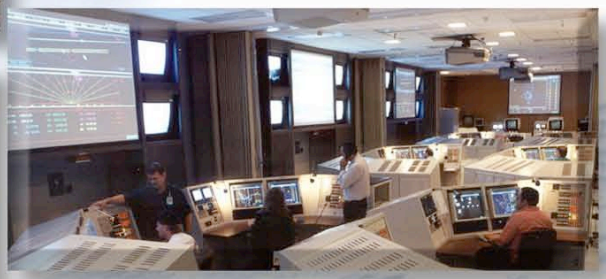
Air Test And Evaluation Squadron Nine (VX-9) conducts operational test and evaluation of all air-to-ground weapons, air-to-air weapons, and software upgrades to aircraft and weapon systems. More than 240 VX-9 Vampires support approximately 16 aircraft for the independent test and evaluation community. The squadron headquarters is at China Lake, with a detachment at Point Mugu. VX-5 moved to China Lake from Moffet Field in 1956, and merged with VX-4 from Point Mugu to become VX-9 in 1995 under the Commander Operational Test and Evaluation Force (COMOPTEVFOR).

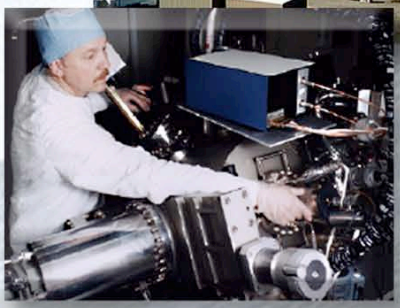
Marine Aviation Detachment (MAD) provides project management, aviation support and technical expertise for assigned Marine Corps weapons systems, subsystems, and mission planning at both China Lake and Point Mugu. Marines assigned to the MAD support multiple RDT&E missions, to include VX-31, and operational test and evaluation at VX-9. The MAD is headquartered at China Lake. MAD was established in 1988 but Marines have been stationed at China Lake since 1943. The MAD operates under the command of the Aviation Department Headquarters, Marine Corps.

Laboratories & Facilities





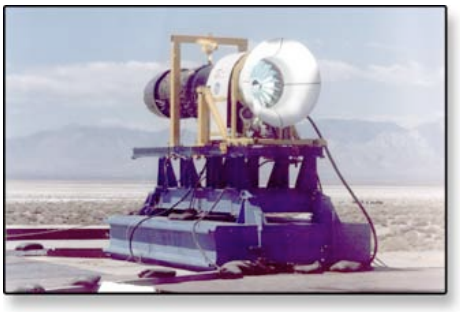






WHAT THE NAVAIR WD DOES BEST

Aircrew Safety And Survivability. Since the 1950s, aircrew safety and survivability have been central to the technical mission of the National Parachute Test Range (NPTR) that was relocated to China Lake in 1979. It was here that the rocket-assisted personal ejection catapult (RAPEC) was designed, developed, tested, and released. RAPEC and subsequent systems have saved the lives of hundreds of aircrew members.

Systems such as the Navy Aircrew Common Ejection Seat (NACES) and China Lake developed and produced Thin-Pack Parachute (now deployed in Fleet patrol (P)-3 Orion aircraft) are of incalculable value in increasing the survivability of military aircrew members. Related efforts conducted at state-of-the-art survivability facilities have led to major improvements in the ability of U.S. aircraft to survive the harsh environment of air combat and bring their crews safely home.



Following the *Challenger* disaster in 1986, China Lake worked with NASA in the evaluation of an emergency escape system for the Space Shuttle. Military test parachutists tested the system from a specially modified Convair-240 aircraft. Scientists and engineers assisted NASA's Pathfinder team by testing the rocket-assisted deceleration (RAD) system as well as designing and fabricating the actual tether system between the RAD and the landing package that was used in the successful Pathfinder landing on Mars in 1997.

During the Mars Exploration Rover (MER) mission in 2004, China Lake designed, built, and assisted in installing the bridle system onto both spacecraft; designed the descent rate limiters (joint effort with JPL); tested the radar systems that were used in timing airbag deployment and retro-rocket ignition; tested the retro-rockets that slowed both landers descent; and conducted multi-body tests involving the parachutes, back-shells, and landers.

Avionics. Avionics integrate a weapon-delivery platform—the aircraft—with its weapons and sensors. From development of the FLIR system, which produced the first-ever 24-hour attack capability, to today's cutting-edge avionics on the F/A-18E/F Super Hornet, WD has played a central role in making avionics one of the chief reasons for U.S. supremacy over its adversaries.

Complex Weapon System Integration. Key aircraft platforms in the current war include the F/A-18, F-14, EA-6B, and AV-8B. WD has Weapon System Support Facilities for F/A-18, F-14, EA-6B, AV-8B, and the AH-1 helicopter. WD also integrates the mission avionics for the special missions EP-3E, supports development of the Joint Strike Fighter (JSF), and supports the Air Force F-22 in Sidewinder weapons integration. WD supports the system design and development phase of the JSF and staff provides systems and software engineering and integration, primarily in the mission systems (avionics) and weapons integrations areas. WD also performs JSF live fire testing, integrated test force, verification and survivability activities.

For the past 20 years, WD has been a world leader in integrating highly complex weapon systems, including the avionics and EW equipment, into naval aircraft. As an example, the F/A-18, the Navy's strike fighter, forms the core of the Navy's air warfare capability. F/A-18s use numerous mission computers with more than 10,000,000 words of code in more than 40 processors. The new F/A18-E/F Super Hornet now has 11 weapon stations and increases weapons carriage, fuel load and range, growth space, and survivability.

The Advanced Weapons Laboratory (AWL) at China Lake is responsible for integrating the weapons, avionics, sensors, EW systems, FLIR, software, and radars into the F/A-18. This laboratory reached the Software Engineering Institute's (SEI) Level 4. This prestigious rating puts AWL in the top 9% of the world's software developers.

Weapons integrated include free-fall bombs (Mk 80 series), foreign and domestic short-range missiles (ASRAAM, Python, AIM-9 series to include AIM-9X), AMRAAM, Sparrow, JSOW, JDAM, SLAM-ER, Maverick (EO and IR), HARM (to include Block 3A/5/6 and the QuickBolt and AARGM series), and the M-60 gun.

In September 2002 the AV-8B Joint System Support Activity (JSSA) achieved the SEI Software Capability Maturity Model (SW-CMM) Level 4. JSSA now ranks in the top 9% of all organizations assessed.

The SEI at Carnegie Mellon University has carefully scrutinized the advanced software practices of more than 1,100 private and government agencies, including Boeing, Raytheon, and Warner Robbins AFB. In an exhaustive process involving more than 4,300 pages of documentation, more than 30 in-depth interviews and five days of on-site assessment, companies are ranked in several areas of technical expertise, including software product engineering, quantitative control processes, software quality processes, and organizational process focus and definition.

Weapon Platform Integration

Electronic Warfare. The EA-6B Systems Integration Facility is the only existing Airborne Electronic Attack (AEA) facility of its kind. Point Mugu has been the center of AEA research, design, and test since 1968.

Point Mugu has eight specialized laboratories. The Prowler's radar and communications-jamming capabilities continue to lead the way in neutralizing enemy air-defense systems in the early days of battle, allowing U.S. fighters free use of the skies. Since 1990, most strike groups insist on the protection of an AEA umbrella. The EA-6B provides cover for the entire strike group, allowing offensive craft to penetrate safely within lethal range of ground missiles and radar. Also at Point Mugu is the Radar Reflectivity Laboratory, the Navy's largest indoor radar reflectivity chamber. Engineers develop, test, and integrate radar warning systems, jammers, decoys, and software. In addition, WD designs, fabricates, and tests the aerodynamic, mechanical, electrical, and structural interfaces.

EW facilities at China Lake include the ECR, the Navy's principal open-air range for T&E of airborne electronic combat. In realistic training just short of actual combat, pilots can fly against simulated air-to-air threats, and surface-to-air threats and complete an air-to-ground strike all in a single mission. The Etcheron Valley Range, with mountains high in iron content, provides a perfect venue for testing directed energy weapons technology and GPS packages in jamming environments without disturbing commercial or military aircraft.

Energetic Materials. Explosives RDT&E has included the development of explosives, warheads, shaped charges, and castable explosives; ordnance safety; ordnance-pollution abatement; and characterization of metals under explosive loading. China Lake was the first to develop plastic bonded explosives (PBX).

Propellant RDT&E began with a concentration on double-base propellants and expanded into work on liquid, smokeless, and alternative solid propellants; combustion instability; manufacturing and storage applications; material and system safety; and liquid, solid, ramjet, and hybrid propulsion systems. China Lake propellant work has also found application in space programs, weather modification, and ejection systems. And China Lake was the first to synthesize the CL-20 energetic molecule, one of the most significant energetic ingredients in the past 50 years.

Thrust-vector-control technology developments have provided the foundations for numerous weapon applications, including vertically launched weapons, and highly maneuverable air intercept weapons. China Lake also refined and developed advanced processes and technologies for explosive forming and welding of metals that revolutionized the industry.

Full-Spectrum Fleet Support. The men and women at WD laboratories, facilities, and ranges are intimately involved with a product from cradle to grave—from concept formulation in response to warfighter requirements, through research, development, manufacturing support, Fleet support, weapon retirement from service; and environmentally compatible system demilitarization.

Fuzing. Advances in fuzing technology at China Lake and its predecessor organization at Corona, California, provided the Navy with a world-class design capability in target-detecting devices (TDDs), contact sensors, electromechanical safety and arming (S-A) devices, and fuze antennas, with hundreds of designs and components in Fleet use. Highly advanced fuze documentation is in widespread use by many North Atlantic Treaty Organization (NATO) countries. Guided-missile warhead fuzes cause the weapon to detonate at the point where the explosion will do the most damage. Fuzes are critical to weapon success. For example, since post-WWII, when the U.S. Joint Chiefs of Staff listed the atomic bomb, radar, and the proximity fuze as the three most significant developments of the war, China Lake has been developing fuzes and components.

Concerning safety and arming (S-A) devices, China Lake has nearly three quarter of a million devices in the Fleet with an outstanding safety record. S-A devices are in use in all Navy guided missiles. Development began in 1953 and continues today. China Lake developed a universal arming and firing device to remotely safe and arm rocket motor ignition devices. S-A devices ensure safety in missile handling, shipping, storage, and launch. The S-A device is a fuze component that isolates the detonator from the warhead booster charge until the launched weapon has achieved a safe distance.

On December 16, 1964 President Lyndon Johnson presented a citation to a team of China Lake/Corona engineers for greatly improving the efficiency/economy of S-A devices by improving operation and reliability and reducing their weight, size, and cost. The new S-A was adapted to almost all Navy missiles. Costs savings for the first procurement exceeded 20 million dollars, and the cost savings since then has far exceeded one billion dollars.

Continuous-slot antennas optimize warhead burst time while also improving countermeasures. The Mk 45 TDD for Standard Missile, an example of this expertise, is considered by many to be the world's premier missile fuze.

Free-fall weapon fuzing work includes the fuze munitions unit (FMU)-140/B dispenser proximity fuze, the DSU-30/B TDD and the FMU-139/B electronic bomb fuze, which increased the reliability of bomb fuzes up to 97% versus 75%. Between 1980 and 1990 more than one million of these fuzes were delivered.

Edge-detection was developed in the mid-1960s and is now used in most Navy anti-air missiles. Edge detection increases the probability of detonating the warhead while the target is within its lethal range, in contrast to a simple timed detonation.

Fore-and-aft adaptive-logic was developed at China Lake and used in long-range missiles. This extension of edge detection uses two beams instead of one. As the missile approaches a target, it size changes from a dot to an extended shape, and the two beams help determine the target size and the optimum time to detonate the warhead.

Pseudorandom-noise modulation was applied to TDD designs to take advantage of spread spectrum techniques in which the transmitted signal is spread over a wide frequency band, providing a lower-density signal than conventional signals. For fuzing applications, it makes the signal difficult to detect, while providing a high-resolution target-detection capability.

Active-optical fuzing, is now used in TDDs for anti-air and anti-surface missiles. TDDs use an active source, usually a laser, to detect the target. The active optical TDD provides high-range resolution information and narrow-beam control, improving the ability to place the warhead fragments on the target. During the Vietnam Conflict, a crash program was begun in 1968 to develop an active optical TDD; China Lake produced the DSU-10/B in eight months.

Laser And Optical Components. China Lake developed optical-component polishing and coating techniques, optics evaluation and instrumentation, surface-absorption measurement, and surface-damage characterization. Accomplishments in laser research range from early development of a night search-and-rescue system that grew out of dye-laser research to the development of the diode laser. Developments also include the interferometric surface scanner; bowl-feed polishing, ultra-high-vacuum deposition, and ultra-clean sputter-deposition optical-film-production techniques; and a portable CO_2 laser.

Modeling And Simulation (M&S). WD's earliest use of M&S was in the creation of analog and digital simulations for weapon systems. Weapon System Support Activity (WSSA) laboratories integrate advanced weapons and components into a total weapon system onboard naval aircraft platforms. M&S plays a major role in this integration process allowing continuous design assessment throughout the process. In the past, live fire testing had been exclusively used to evaluate how a missile system functions. WD pioneered simulation based acquisition (SBA).

The use of M&S during development has saved tens of millions of dollars over the years. Using hardware-in-the-loop (HWIL), WD integrates part of the missile hardware, such as the seeker or control section, into the simulation, running in real time. Part of the missile functions in the laboratory as though it were in actual flight. During the 1970s and 1980s, HWIL reduced the number of live firings required to field Sidewinder, Sparrow and RAM. In the 1960s the AIM-9D required 129 live firings to prove out its performance. By 1981 the AIM-9M required only 35 live firings. Total acquisition risk was also significantly reduced because extensive use of HWIL simulations solved design problems early in the developmental cycle when they could be fixed at a much lower cost with much less schedule impact.

During the 1990s WD developed signal-processor-in-the-loop (SPIL) advanced simulations made possible by high performance computers and custom digital processors. SPIL creates very complex target scenes, including a detailed model of the seeker front end, and then injects the seeker sensor output directly into the real missile signal processing hardware. SPIL significantly contributed to the Sidewinder, Sparrow, RAM, and SLAM programs. Simulations also allow engineers to better understand threat missile systems, particularly the man portable air defense systems (MANPADS), against our own aircraft.

Today, WD uses advanced simulation technology to link geographically separated facilities such as the Integrated Battlespace Arena (IBAR), global positioning system (GPS) Laboratory, and F/A-18 Advanced Weapons Laboratory (AWL) at China Lake; the Interoperability Test and Evaluation Complex (ITEC) at Point Mugu; and the Air Combat Environment Test and Evaluation Facility (ACETEF) at Patuxent River into a total "virtual" battlespace.

Test, Evaluation And Training. Each year WD conducts more than 3,000 test events, close to 300 major training events, and about 2,000 training sorties. WD evaluates weapons, components, and systems in realistic environments; conducts full-scale, joint-live-fire survivability testing; and tests guns and ammunition, explosives, and propellants. WD can safely detonate up to 500,000-pounds of explosives

without public complaints. Other testing activities include GPS jamming, high power microwave, and firefighting agents and devices. WD maintains the world's largest collection of "shootable" antiradiation missile targets for test activities. WD conducts extensive modeling and simulation in numerous specialized facilities; and China Lake has served as the National Parachute Test Range (NPTR) since 1979.

Training The Fleet. WD also helps train the Fleet—from simple to complex. WD can support anything from one aircraft on one target to complex battlespace scenarios involving multiple sites and multiple players. Fleet Training Exercises, and Fleet Battle Experiments, FBEs, are becoming increasingly complex, and WD is becoming more involved.

Since the late 1990s, WS has been involved in eight major exercises. Each year, the Division conduct complex "what if" battle group scenarios to see how well all the weapons systems play out in real time. The goal is to see what works and what doesn't. In 2002, WD completed the Millennium Challenge, named FBE-Juliet. The Sea and Land Ranges were the site of live action by joint forces.

Efforts were orchestrated from the Interoperability Test and Experimentation Center at Point Mugu, and the Integrated Battlespace Arena at China Lake.

Each year, allied customers from many nations send hundreds of troops to train for conflict and test weapons on WD's ranges.

Allies include Australia, Canada, Great Britain, Switzerland, Italy, and Norway. The Japanese are one of WD's largest customers on the Sea Range.

At Superior Valley, WD has tactical targets and automatic weapon scoring systems where WD trains pilots, including F/A-18 squadrons from Lemoore. WD also conducts search-and-rescue training and helicopter mobile assault training. And on the Electronic Combat Range, pilots can fly against actual threat radar systems. They can fly HARM missions, practice tactics, and use countermeasures.

Warhead Design. Since the 1950s, China Lake has served as the warhead design agent for most Navy missiles and free-fall weapons, providing quick response production. Examples include **Anti-surface weapons:** Harpoon, Tomahawk, Penguin, Maverick, Condor Shrike, HARM, Standard Antiradiation Missile (ARM), SLAM-ER, Air Launched Tacit Rainbow, Ground Launched Tacit Rainbow, and Zuni 5.0-Inch Rocket. **Free Fall Weapons:** Bombs, Skipper, Walleye, Rockeye, APAM, Fuel Air Explosive (FAE), and FAE II. **Anti-Air Weapons:** Rolling Airframe Missile (RAM), Sparrow, Sidewinder, and AMRAAM.

Family of Weapons

FAMILY OF WEAPONS

WD expertise has been applied in the majority of the U.S. family of air-, surface-, and sub-surface-launched weapons. The current family includes AMRAAM, JDAM, JSOW, Sidewinder, HARM, Trident, Tomahawk, RAM, Standoff Land-Attack Missile–Expanded Response (SLAM-ER), and ESSM. Through the years, WD has played every role in weapon development. Currently WD is working directly or indirectly on 25 different weapons and weapons systems for the Fleet. WD is the primary technical lead for 15 systems, and we provide other engineering or T&E support to dozens of other weapons, projects, and programs. The Division acquires, develops, tests, and evaluates weapon systems, and introduces new weapons to the Fleet, providing life-cycle support for many weapons used by the Navy, Marine Corps, Air Force, and numerous foreign countries.

Pioneered Technologies That Influence Today's Military Arsenal.

Precision guidance in IR–Sidewinder missile.
Invented and developed the Sidewinder missile.

Antiradar (passive RF) guidance–Shrike, HARM, AARGM. China Lake developed Shrike, which begat HARM.
Developed the HARM low-cost seeker.

TV guidance. China Lake developed Walleye, the archetype of all modern TV-guided weapons.

Technologies for proximity fuzing, warheads, solid rocket propulsion, and thrust vector control (TVC).
TVC is currently used on SeaSparrow, Tomahawk, VLA, AIM-9X Sidewinder, and Standard Missile.

A systems approach to weapon integration on naval platforms versus integrating weapons as an "afterthought."

Conflict Involvement. In Kosovo, China Lake and Point Mugu influenced HARM, JDAM, JSOW, and Tomahawk weapons. During Desert Shield and Desert Storm, China Lake re-invented the FAE weapon to help clear minefields for the Marines. In addition, the Center conceived and developed the Sidewinder missile, the world's most accurate, reliable, and successful dogfight missile, along with Walleye, Shrike, FAE weapons, FFARs, forward-looking infrared (FLIR) technology, and the "Eye" series of free-fall weapons. A survey by the Office of the Chief of Naval Material rated China Lake the top Navy Laboratory in the 1970s. China Lake developed more than 75% of all air-to-air and air-to-ground weapons used in combat in Vietnam, according to Robert McNamara, Secretary of Defense. In the Korean War China Lake produced and delivered the 6.5-inch tank-killing rocket, RAM, to Korea in just 29 days; the Michelson Laboratory hall was turned into a crash production facility for RAM fuzes. In WWII, China Lake developed, tested, and trained pilots and crews to fire the aircraft rockets and bombardment rockets that affected the outcome of the war.

QUICK FLEET RESPONSE ACHIEVEMENTS

Operation Iraqi Freedom (OIF). Since 1943 China Lake and Point Mugu have demonstrated a quick-response capability that has saved lives, equipment and money. Quick response depends on a close operating relationship between the Fleet and WD.

WD accelerated and deployed the F-14D Operational Flight Program (OFP) D04 software to all F-14D squadrons on three carriers in two oceans in three weeks. F-16 JDAM software was quickly tested on the China Lake Ranges before it could be sent back to Iraq. Elapsed time from first call until the software was on its way to Iraq was 30 hours. In addition, the F/A-18 shared-reconnaissance pod (SHARP) development was accelerated and approved for early deployment. WD's Warfighter Response Center was manned around-the-clock resolving difficult issues for the Navy, Marine Corps, Army, and Air Force. For example, an Air Force pilot experienced some problems dropping a particular weapon in theater. Within hours WD engineers were testing a proposed solution on the land range. That same day, the fix was on its way.

> *"And as F-16s flying missions in Operation Iraqi Freedom were having problems delivering their munitions, experts at Hill AFB, Utah; Edwards AFB; and NAWCWD, China Lake, California, worked together and found a fix an amazing 30 hours later. That's the kind of warfighter support our Air Force wants, needs, and continues to get."*
>
> —General Greg Martin, Commander, Air Force Reserve Command, Wright Patterson AFB, Ohio

WD also designed, developed, and built a new metal augmented charge (MAC) warhead for the Hellfire Missile that went from development to deployment in less than a year. The new warhead provides increased effectiveness against multi-room structures. The effects are formidable.

> *"[The Hellfire] can take out the first floor of a building without damaging the floors above, and is capable of reaching around corners, into niches, and behind walls to strike enemy forces hiding in caves, bunkers, and hardened multi-room complexes. It went from development to deployment in less than a year."*
>
> —Donald Rumsfeld, Secretary of Defense

QUICK FLEET RESPONSE ACHIEVEMENTS

Operation Enduring Freedom (OEF). JDAM and JSOW refinements and upgrades were accelerated as were F-14B OFPs, F/A-18 software block upgrades, and new electronic warfare (EW) suites. In addition, range testing and training activities were accelerated, involving the Tomahawk, Hellfire, AMRAAM, JSOW, and Harpoon. Point Mugu provided round-the-clock support with the EA-6B Prowler Program.

China Lake also invented and developed the Tactical Dissemination Module (TDM), a revolutionary new portable computer/radio system that creates customized real-time-targeting strike packages for specific aircraft. For example, a special operations force identifies a time-critical target. Next, they digitally photograph the target, determine the approximate global positioning system (GPS) coordinates, and then transmit the data back to Central Command (CENTCOM), who decides which weapon is currently available (target weapon pairing), in order to make the call for fire (CFF). During Operation Iraqi Freedom, as coalition forces captured Baghdad International Airport, the Forward Dissemination Element (FDE) was immediately relocated there for the duration of the conflict. TDM supplied more than 900 target packages to coalition bombers and is still forward-deployed. TDM is scheduled to be installed on six U.S. Navy ships in FY04.

Kosovo. Navy, Air Force, and allied aircraft fired more than 1,000 HARMs during the air campaign in Kosovo. A HARM Tiger Team from WD deployed to Italy to support forward-deployed forces. The team reloaded up-to-date missile software in more than 400 missiles in 36 days. HARM subject matter experts provided on-site training and technical support to the aircrews, mission planners, and ordnance handling personnel. When additional mission scenario data was needed, to allow HARM to attack new threats, WD accelerated development and deployed it to the Kosovo Theater in less than four weeks.

Desert Fox. A rapid response was provided to deployed forces onboard *USS Nimitz* in the Persian Gulf. The response provided military technicians with new maintenance tools designed and built by F/A-18 Facilities Task Team personnel. In addition, Carrier Air Groups (CAGs) deployed in support of Operation Desert Fox urgently requested some of the first-production JSOW air-to-ground missile (AGM)-154A assets in support of operations. WD studied the feasibility, identified software incompatibilities, prescribed a fix, and conducted testing in the F/A-18 AWL at China Lake. WD quick-response team was formed and traveled to McAlester Army Ammunition Plant, Oklahoma, and reprogrammed JSOWs with software compatible with the deployed system.

Desert Storm/Desert Shield. China Lake and Point Mugu responded with quick-reaction, on-demand requests to support operating forces and troops in the Persian Gulf. Engineers modified, improved, tested, and validated various aspects of the Sidewinder, Tomahawk, FAE, HARM, and Shrike weapon systems. Point Mugu also developed EW system upgrades, developed and hand-delivered OFP upgrades, and developed and fielded weapon-integration and weapon-targeting software for combat aircraft.

Vietnam Conflict. During the Vietnam Conflict an immediate need arose for a specialized TDD for the Standard ARM (antiradiation missile). In only eight months, China Lake/Corona developed and fielded a new active-optical TDD, the DSU-10/B. In addition, through the Vietnam Laboratory Assistance Program (VLAP), China Lake provided scientific/technical advisors to the Fleet and the Marines Tasks were of a quick-response nature: quick fixes, typically inexpensive, to emergent problems. Some 50 tasks were addressed by China Lake personnel. Included were a small beacon for use by ground troops in identifying themselves to A-6 attack aircraft (1968), map illuminators (1969), hand-emplaced FAE canisters for mine clearance (1970), and a lightweight gun pod for the Marines. China Lake also provided direct support to the Special Forces community with custom explosives and devices, night-vision signals and devices, and specialized weapons and grenades, communications gear, and unique support equipment.

Cuban Missile Crisis. In 1962 the Soviets had set up medium-range nuclear missiles in Cuba with complicated arrays of radar defending missile sites. The U.S. had no antiradar missile, but Shrike was under development at China Lake. An urgent message was received to provide Shrike missiles at once, even though the development program was not completed. Two hundred missiles were built, about half produced in-house at China Lake.

Korean War. During the Korean War an urgent request came from the field for a weapon to defeat 13-inch tank armor. Within 29 days China Lake developed a shaped-charge warhead to match with the five-inch high-velocity aircraft rocket (HVAR) motor and produced RAM, a 6.5-inch Antitank Aircraft Rocket (ATAR). RAM was designed, tested, documented, and produced at China Lake, and put in service in Korea.

WWII. In WWII the Navy-Caltech team at China Lake created "Holy Moses," one of the most effective and widely used U.S. rockets of war.


Iraqi Freedom
2004
Enduring Freedom
2001
Kosovo
1999
Desert Fox
1998
Bosnia
1992-1995
Arming The Fleet
Desert Shield/ Storm
1991
Vietnam
1956-1975
Korea
1950-1953
WWII
1941-1945


CAPTURED

ARMING THE FLEET

Table of WD-Influenced Weapons in Conflict

During every major U.S. military crisis since WWII, RDT&E work at China Lake and Point Mugu, has played a significant role: developing and testing weapons and systems that work!

✓ = Active Fleet Inventory

◯ = Used in Combat

	Iraqi Freedom (2003-Present)	Enduring Freedom (2001-Present)	Kosovo (1999)	Desert Fox (1998)	Bosnian Conflict (1992-1995)	Desert Storm (1991)	Vietnam Conflict (1956-1975)	Korean War (1950-1953)	World War II (1941-1945)
AMRAAM	✓	✓	◯	◯	◯	✓			
ASROC / VLA	✓	✓	✓	✓	✓	✓	✓		
Atomic Weapon Non-nuclear components									◯
FAE	✓	✓	✓	✓	✓	◯	◯		
Fleet Ballistic Missiles	✓	✓	✓	✓	✓	✓	✓		
Gator		✓	✓	◯	✓	◯			
General Purpose Bombs	◯	◯	◯	◯	◯	◯	◯	◯	◯
HARM	◯	◯	◯	◯	◯	◯			
Harpoon, SLAM, SLAM-ER	◯	◯	◯	✓	✓	◯			
Hellfire	◯	◯	◯	◯	◯	◯			
JDAM	◯	◯	◯						
JSOW	◯	◯	✓	✓					
Laser Guided Bombs	◯	◯	◯	◯	◯	◯	◯		
Maverick	◯	◯	◯	◯	◯	◯	◯		
Phalanx	✓	✓	✓	✓	✓	✓			
Phoenix	✓	✓	✓	◯	✓	✓			
Rockets	◯	◯	◯	◯	◯	◯	◯	◯	◯
RAM	✓	✓	✓	✓	✓				
Shrike	✓	✓	✓	✓	✓	✓	◯		
Sidewinder	✓	✓	✓	✓	◯	◯	◯		
Skipper						◯			
Sparrow, Sea Sparrow, ESSM	✓	✓	✓	◯	✓	◯	◯		
Standard Missile	✓	✓	✓	✓	✓	✓	◯		
Tomahawk	◯	◯	◯	◯	◯	◯			
Walleye	✓	✓	✓	✓	✓	◯	◯		

NOTE: Middle East and Falklands, Iran/Iraq War, Cuban Missile Crisis - Although direct combat involvement by U.S. Navy forces was either minimal or advisory, many of the weapons and systems developed and tested by China Lake and Point Mugu and deployed by the Fleet were used as deterrents during these conflicts.

WD-INFLUENCED WEAPONS

AMRAAM. The AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) is an all-weather, beyond-visual-range, supersonic aerial-intercept guided missile that uses active radar target tracking and target detection and proportional navigation guidance. During Operation Iraqi Freedom, Point Mugu teams reprogrammed AMRAAMs with updated software.

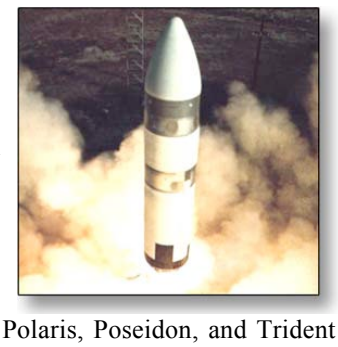
ASROC. The Antisubmarine Rocket (ASROC) is a quick-reaction, all-weather, intermediate-range, Antisubmarine Warfare (ASW) weapon launched from surface ships. ASROC consists of a torpedo, a double-base propellant rocket motor, an ignition separation assembly, and a dome-shaped plastic nose cap that protects the torpedo's transducer assembly as the weapon enters the water.

Vertical Launch ASROC (VLA) is an improved rocket-propelled, ASW weapon designed for deployment on ships equipped with the Mk 41 Vertical Launching System. In 1978, a major milestone was achieved at China Lake when the first vertically-launch-controlled ASROC airframe was launched from a prototype of the Mk 41 Vertical Launching System. Several years later the formal VLA Development Program was initiated, and VLA missiles were introduced into the Fleet in March 1993.

Atomic Weapons. Of all the "weapons that win wars," the ones that can best lay claim to this title are the first atomic bombs, Fat Man and Little Boy, which ended World War II. China Lake was a major contributor to the success of those weapons. An atomic bomb is essentially a conventional bomb with a nuclear core. The China Lake/California Institute of Technology (Caltech) Team, experts at conventional explosives, was tasked to develop the non-nuclear explosive components of the atomic bomb.

FAE. Fuel air explosives (FAE) weapons use an explosive charge to disperse liquid fuel into the air, which creates an aerosol fuel/air cloud. When the cloud reaches an optimized mixture, it is ignited by a detonator, creating a shock wave front that is useful against soft targets such as minefields, personnel, aircraft in the open, and bunkers. FAE has also been used for creating clearings in forests and jungles. Since 1960, China Lake has developed FAE weapons and devices, including two 550-pound weapons, the CBU-55 and CBU-72 cluster bombs, both containing three FAE submunitions loaded with ethylene oxide liquid fuel.

Fleet Ballistic Missiles. Fleet ballistic missiles are large, long-range, submarine-launched missiles equipped with nuclear warheads. Although never fired in combat during more than 40 years of service, Fleet ballistic missiles have played a central role in the U.S. policy of strategic deterrence. China Lake's work on, Polaris, Poseidon, and Trident have advanced the state of the art in thrust-vector-control systems, propellant efficiency and safety, and large rocket-motor technology. Work has included basic research, engineering and advanced-development efforts, support for operational systems, and technical advice. China Lake's greatest efforts have been in propellant hazard evaluation and aging characterization, as well as testing and evaluating propulsion systems. The early China Lake studies had a profound effect in shaping the country's strategic deterrence policies, which contributed to international stability. In November 2003 WD was given a Trident Command Flag commemorating the 20th anniversary of Trident I missile launches at Point Mugu.



Gator. Gator is an aircraft delivered, unguided, target-actuated triservice anti-personnel and anti-tank munitions (landmine) delivery system. It is used primarily against area targets such as tanks, armored vehicles, trucks, radar installations, surface-to-air-missile (SAM) sites, parked aircraft, and other materiel. The Gator system was originally developed by China

Lake as part of the "eye" series of free-fall weapons. The free-fall weapon program was initiated at China Lake in 1959 to develop new free-fall bombs and systems that would improve the Navy's air-attack.

General Purpose Bombs. The Mk 80 weapons are air-to-surface, free-fall, non-guided, general purpose (GP) bombs, including the 250-pound (Mk 81), 500-pound (Mk 82), 1,000-pound (Mk 83), and 2,000-pound (Mk 84) versions. The Mk 80 series was developed in the 1950s in response to the need for bombs possessing less aerodynamic drag, for operation on jet aircraft. Bombs are fitted with either a nose or tail fuze to meet specific tactical needs such as fragmentation, blast, cratering, or penetration. They can also be used for land or sea mines. Later versions, including the Mk 82/83/84, can be modified with a high drag tail assembly for low-altitude delivery. China Lake and Point Mugu have been actively involved with RDT&E of bombs since WWII.

HARM. The High-Speed Antiradiation Missile (HARM) is an air-to-surface guided missile used to seek out and destroy enemy radar systems. HARM was conceived at China Lake and became a joint Navy-Air Force project. China Lake pioneered antiradar (passive RF) guidance for the Shrike missile, which evolved into HARM to meet Fleet needs for a wide-frequency coverage high-speed anti-radiation missile. The basic overall design, including seeker, warhead, and fuze, were developed at China Lake, which also developed a procurement package for a second-source competition. China Lake, as lead laboratory, provided technical management to prove the concept and to establish feasible performance specifications. During Operation Iraqi Freedom, Point Mugu responded to more than 100 Fleet requests concerning EW data, and generated electronic intelligence files enabling HARMs to defeat new threat radars.

Harpoon. The AGM/RGM/UGM-84 Harpoon is an autonomous, all-weather, over-the-horizon, antiship missile system providing the Navy and Air Force with a common missile for air, ship, and submarine launches. Developed in the early 1970s, Harpoon is one of the most widely exported Navy weapon systems, with more than 30 nations fielding the system. The first missile was delivered in November 1988, and was test fired at Point Mugu.

SLAM. In the late 1980s, the Navy needed a land-attack missile. Rather than design one from scratch, the Navy took everything from Harpoon except the guidance and seeker sections, added a GPS receiver, a Walleye optical guidance system, and a Maverick data-link to create SLAM. SLAM is an intermediate-range system, effective against high-value land targets and ships in port.

SLAM-ER. SLAM-ER is a significant improvement over SLAM. It is a day/night, adverse-weather, over-the-horizon, precision strike missile addressing the Navy's requirements for a precision-guided Standoff Outside of Area Defense weapon.

Hellfire. The helicopter launched AGM-114 Hellfire missile is an air-to-ground missile that provides heavy antiarmor capability to attack helicopters. The first three generations of Hellfire use a laser seeker. The fourth generation, Longbow Hellfire, uses a radar frequency seeker. The first generation Hellfire was the main armament of the Army's AH-64 Apache. The second and third generations of Hellfire, the AGM-114B/K, are the main armament of the Marine Corps' AH-1W Super Cobra. Laser Hellfire homes on a laser spot that can be projected from ground forces, other aircraft, or the launch aircraft itself, enabling the system to be used in a variety of modes. Hellfire is effective against armored vehicles and concrete bunkers. During 2000-2001, WD provided systems engineering support and testing. Tests included developmental, insensitive munitions, safety and safe-separation, flight, and warhead performance. WD also investigated fixed-wing requirements, used advanced simulations to study proposed concepts, and provided survivability assessments and personnel training. In support of Operation Iraqi Freedom, WD also designed, developed, and built a new metal augmented charge (MAC) warhead for the Hellfire Missile that went from development to deployment in less than a year. The effects were formidable.

JDAM. The Joint Direct Attack Munition (JDAM) is a low-cost, inertial guidance kit that is attached to an unguided free-fall bomb, converting it to an accurately guided "smart" weapon. This strap-on Global Positioning System (GPS)/inertial navigation system (INS) guidance kit improves the accuracy of general-purpose bombs. JDAM was developed to meet the need for an adverse-weather, accurate-strike capability in response to lessons

learned during Desert Storm. JDAM is a joint Air Force/Navy weapon system. The Air Force serves as the lead, and WD serves as the Navy's technical agent for JDAM. WD provides Fleet technical support as well as support for contractor testing, mission planning and development, and logistics.

JSOW. The Joint Stand-Off Weapon (JSOW) is an air-to-surface, unpowered, guided glide weapon. JSOW is a launch-and-leave weapon that uses GPS/INS and is capable of day/night and adverse weather operations. Aircrews have the ability to attack multiple targets in a single sortie. JSOW is delivered in three variants: baseline, antiarmor, and unitary (penetrator). WD played a significant role in the successful delivery of the first JSOW, overseeing development and preparing the Fleet for its introduction. The first flight test took place in December 1994 from an F/A-18C Hornet at China Lake. JSOW is a joint Navy-Air Force weapon program, with the Navy as the lead service. WD is the Navy's Technical Agent for joint development.

Laser Guided Bombs. Laser guided bombs (LGBs) are air-to-surface general-purpose bombs modified with laser-guidance kits. LGBs are used for precision attacks on surface targets. An airborne or surface designator illuminates or "tags" the target with a laser, and the weapon homes in on the reflected laser energy. LGBs are excellent performers in dive deliveries from medium altitudes. Laser guided technology has greatly enhanced the effectiveness of general purpose bombs. For example, in WWII it would take thousands of bombs to hit a target the size of an aircraft shelter. In Vietnam, 300. Today, it can be done with one laser guided bomb. WD continues its role as the Navy production and in-service engineering agent for Laser Guided Bombs.

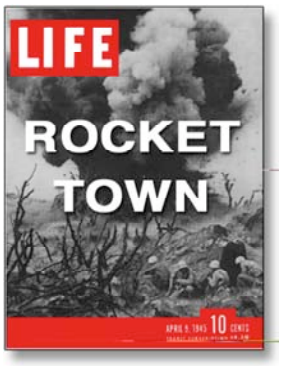
Maverick. Maverick is an air-to-surface tactical missile designed for close air support, interdiction, and defense suppression. It provides stand-off capability and high probability of kill against a wide variety of tactical targets, including air defenses, ships, ground transportation, armor, and fuel storage facilities. Guidance systems used by Maverick include infrared, laser and TV. Maverick is exported to more than 25 countries. Maverick was originally developed for the Air Force beginning in the mid 1960s, and the first deliveries were made in 1972. Subsequently, China Lake became heavily involved in modifications and refinements to the system.

Phalanx. The Mk 15 Phalanx Close-In Weapon System (CIWS) is a fast-reaction, computer-controlled rapid-fire 20-millimeter gun system providing U.S. Navy ships with a terminal defense against antiship missiles that have penetrated other Fleet defenses. It is designed to engage antiship cruise missiles and fixed-wing aircraft at short range. Incorporating a self-contained radar with integrated forward-looking infrared (FLIR), Phalanx automatically performs search, detecting, tracking, threat evaluation, firing, and kill assessments of targets. WD's involvement with Phalanx has been in the area of test and evaluation. Phalanx has tested on the Land Range since the late 1970s.

Phoenix. Phoenix is a long-range, all-weather, radar-guided air-to-air missile carried on the Grumman F-14 Tomcat. Phoenix, the Navy's only long-range air-to-air missile, is mated with either the AWG-9 or AWG-17 radar/fire-control system, which can track up to six Phoenix missiles fired against separate targets simultaneously. The improved Phoenix, the AIM-54C, was designed to counter projected threat tactical aircraft and cruise missiles. WD's involvement with Phoenix has been in the area of test and evaluation and extensive technical and design support. Point Mugu's F-14 Weapons Systems Integration Laboratory supports software and avionics integration for the F-14 Tomcat and Phoenix missile systems.

RAM. The RIM-116A Rolling Airframe Missile (RAM) is a lightweight quick-reaction high-firepower surface-to-air weapon designed to counter antiship missiles. There are more than 100,000 in the world's inventory today. RAM is a joint U.S. and German venture to design an effective, low-cost, ship self-defense system. RAM is a 5-inch passive dual-mode radio frequency (RF) and infrared (IR) fire-and-forget missile that uses Sidewinder technology for the warhead and rocket motor. Because of its high-tech guidance system, RAM requires no

shipboard support after the missile is launched. RAM is effective against a wide spectrum of threats and it supplements Phalanx and SeaSparrow in the ship's defensive arsenal. RAM is currently installed, or planned for installation, on more than 80 U.S. Navy, 28 German Navy, and three Korean ships. China Lake was the U.S. government's lead technical agent for the development of the RAM. Initial development began in 1974, and production was initiated in 1987.



Rockets. Rockets are air- and surface-launched, unguided, rocket-propelled ballistic trajectory weapons. In 1941, Pearl Harbor drove home a hard lesson in naval air strike warfare: there was a great need for superior aircraft weapons. China Lake (then known as the Naval Ordnance Test Station (NOTS)) was established as a proving ground for developmental rockets. Early rockets developed by the California Institute of Technology (Caltech)/China Lake team included the 2.75-, 3.5-, and 5.0-inch aircraft rockets; the 5.0-inch High-Velocity Aircraft Rocket (HVAR) Holy Moses; and the 11.75-inch Tiny Tim. The 3.5-inch fixed-fin rocket was the first forward-firing aircraft rocket used by American troops during World War II. Early rocket work laid the foundation for China Lake's later efforts in rockets, missiles, propellants, warheads, launchers, and fire-control systems. By the end of World War II, China Lake/NOTS had conducted more than 1,000 projects, and the base was well on its way to becoming the largest Navy-built, Navy-managed community. It had emerged as the Navy's lead laboratory, with the most completely instrumented ranges in the nation for rocket and midrange, guided-missile testing.

Shrike. AGM-45 Shrike is a passive-homing air-to-ground missile whose mission is to home on and destroy radar transmitters used by the enemy to direct ground antiaircraft batteries and surface-to-air missiles. Shrike was the first missile to be mass-produced specifically for the U.S. antiradar mission. Shrike-On-Board was a quick-reaction program during Vietnam to put Shrike on destroyers. Beginning in 1958, China Lake conceived, developed, and tested Shrike, the world's first successful antiradar missile, as a direct response to Fleet needs. China Lake pioneered antiradar (passive RF) guidance for Shrike, the High-Speed Antiradiation Missile (HARM), and the Advanced Antiradiation Guided Missile (AARGM). China Lake first developed Shrike, which begat HARM.

Sidewinder. Sidewinder is a supersonic, heat-seeking, air-to-air, guided missile carried by fighter aircraft. It has a high-explosive warhead and a passive infrared guidance system. It is carried by many types of aircraft, both fixed wing and helicopters. With more than 200,000 produced for 46 nations excluding the U.S., the AIM-9 is one of the oldest, least expensive, and most successful missiles in the entire U.S. weapons inventory. China Lake conceived, designed, and developed the Sidewinder in the early 1950s. For the AIM-9M, WD serves as the design agent, providing production support, data management, design changes, modeling and simulation, and logistics. For the AIM-9X, WD is providing system engineering, system performance specifications, threat models and analysis, developmental testing, signal processor in the loop (SPIL) facility, and logistics.

Skipper. The AGM-123 Skipper II is a short-range precision-attack missile, consisting of a modified Paveway II laser guidance system and a Mk 78 Shrike motor attached to a Mk 83 1,000-pound general-purpose bomb. It is a standoff antiship missile based on existing missile and bomb components. The rocket motor was derived from the AGM-45 Shrike antiradar missile. China Lake designed and developed Skipper II as a powerful modification to the Paveway II family of guided bombs.

Sparrow. The AIM/RIM-7 Sparrow is a highly maneuverable, medium-range, semi-active, air-to-air (AIM-7), and surface-to-air (RIM-7) missile. Sparrow is controlled by four delta wings and propelled by a dual-thrust solid-propellant rocket motor. In air-intercept applications, the launch aircraft illuminates the target with its radar throughout the missile's flight, as does the ship in a surface-launch engagement. At intercept, an active radio-frequency fuze detonates the high-explosive warhead. Sparrow is an all-weather missile that can attack high-performance aircraft and missiles. Sparrow I began in 1946 and made the first U.S. kill of an airborne target in 1952 at Point Mugu.

SeaSparrow. The SeaSparrow surface-to-air missile system can destroy hostile aircraft and antiship missiles. The first Sea Sparrow shipboard launch took place in 1972. A vertical-launch system was tested in 1981, and SeaSparrow RIM-7M, along with the AIM-7M Air Sparrow, entered service in 1983.

The AIM/RIM-7M missile upgrade (from the AIM-7F) has an inverse monopulse semiactive radar seeker, improved electronic counter-countermeasures, digital microprocessing, a new warhead, and active radar fuze. AIM/RIM-7P began development in 1987, and deliveries of the –7P missile began in 1991. The –7P has a low-altitude guidance system that is effective against very low sea-skimming cruise missiles.

Evolved SeaSparrow Missile (ESSM). By 1995 the Engineering and Manufacturing Development of the ESSM had begun. The RIM-162 is a kinematic improvement to the RIM-7 SeaSparrow missile with a primary mission of destroying low altitude highly maneuverable anti-ship cruise missiles. The missile incorporates the use of midcourse data links in order to provide ship based corrections during flight. The ESSM is an international, cooperative, major upgrade of the RIM-7 NATO SeaSparrow missile. During 2000 and 2003, WD completed development and operational testing of the ESSM, supported transition to low-rate initial production, and assisted in developing a six-degree-of-freedom simulation model. WD has provided Sparrow technical support to 20 countries through the years.

Standard Missile. Standard Missile (SM) is the Navy's primary surface-to-air Fleet defense weapon and is widely deployed on Navy ships. It is the descendant of an earlier missile project known as "Bumblebee," which included Terrier, Tartar, Talos, and Typhon. The newer SM concept minimized compatibility changes and was modular in design for ease of upgrade. SM, one of the most reliable weapons in the Navy's inventory, began development in 1964, entered service in 1968, and has steadily evolved. The three main sub-types include SM-1, Standard ARM, and SM-2. China Lake was both the design agent and technical direction agent for all SM fuzing (TDD, S-A device, and fuze contact device) and portions of the flight-termination system in the SM-1 and SM-2.

The China Lake-developed Mk 45 TDD for SM is considered by many to be the world's premier missile fuze.

WD is the technical direction agent of NAVSEA for the Mk 45 Mods 9, 10, and 14 TDDs and the technical direction and design agent for the S-A device, arming-firing device, and fuze contact device. WD will aid in development planning and contract formulation for the SM-6 program, scheduled to begin in 2004.

Tomahawk. Tomahawk is a long-range, surface-to-surface, guided, subsonic cruise missile used for land attack from submarines, and surface ships. Tomahawk flies at extremely low altitudes at high subsonic speeds and over evasive routes for increased survivability. Targets are often high-value land assets in high-threat areas. Radar detection of the Tomahawk is difficult because of the missile's low radar cross-section and low-altitude flight. Infrared detection is difficult because the turbofan engine emits little heat. Tomahawk has inertial and terrain contour-matching radar guidance that uses a stored map reference on board to compare with the actual terrain to determine the missile's position. Surface-launched cruise missile development began in 1972. Tomahawk's first developmental flight tests and simulations were conducted at Point Mugu in the mid 1970s, and in 1978 the first submarine launch was made off Point Mugu. Tomahawk Initial Operating Capability came in 1983. During 2000 and 2001, WD supported three major efforts, including the Penetrator Variant for deep targets, Tactical Tomahawk, and Block II/III.

China Lake is the Navy's Principal Support Activity for the Tomahawk, the Acquisition Engineering Agent for the all-up round, the Software Engineering Agent and the Engineering Design Agent for the Tactical Tomahawk Penetrator Variant Warhead.

Walleye. The AGM-62 Walleye is a precision-guided (television) air-to-surface glide weapon. It is used primarily against targets such as fuel tanks, tunnels, bridges, radar sites, port facilities, and ammunition depots. Walleye I and II are linear shaped charge warheads fitted with a TV seeker head, a set of aerodynamic control surfaces, and a tail-mounted datalink. The weapon has evolved into numerous versions, including the original Walleye I Extended Range Data Link (ERDL), Walleye II, and the Walleye II ERDL. China Lake conceived, designed, developed, and tested Walleye—the first precision-guided air-to-surface weapon. China Lake was the lead laboratory for the entire development, from concept to production.

FLEET PROGRESS ON MANY FRONTS

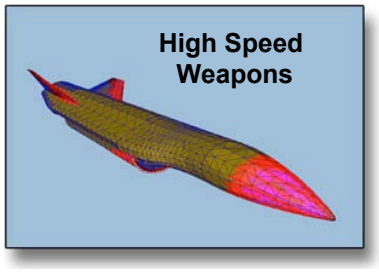
FUTURE WARS – FUTURE WEAPONS

Future Ordnance Systems. WD is now working on the weapons of tomorrow. Future ordnance systems will include improved reactive composite cases and impulsive energy weapons with flux compression, very high velocity directional fragments, and electromagnetic pulse (EMP). New explosive fills in development contain reactive metal enhancement, super brisant, and thermobaric qualities; and directional, super/hyper sonic, and mission responsive weapons are also in development. Conventional improvements will involve internal blast, battle damage assessment (BDA), initiation systems, multi-mode, miniature ESAD, sensors, submunition dispensing, penetration materials, and pyrophoric/fire start. Ordnance effectiveness will be enhanced via predictive model simulation and thermobaric modeling. Aircraft, guns, and ammunition of the future will include lead-free, medium-caliber ammunition primers and heat and water resistant "green" gun barrels. Aqueous based parts cleaning solvents will be used to meet modern environmental regulations.

Teaming For Homeland Defense. As part of a NAVAIR initiative to provide greater assistance and support to the Coast Guard, NAVAIR WD and Naval Base Ventura County are exploring options to assist the Coast Guard as it executes its Deep Water Program, a multi-year, multi-phase effort to replace all its vessels, aircraft, and technology.

Energetics. NAVAIR maintains a full-spectrum energetics RDT&E capability to support the development and acquisition of Navy weapon systems. NAVAIR attracts top-ranked people and maintains a world-class energetics capability while partnering with industry and academia. Examples of recent technology include CL-20, a molecule that enables the world's most powerful explosive currently available, and hypersonic propulsion systems for weapons that will exceed Mach 4. The NAVAIR energetics business base includes Navy air- and surface-launched weapons and other service and Defense Agency programs. Energetics constitutes over $100 million and 800+ workyears at NAVAIR WD annually including basic research in combustion sciences, firefighting technology, insensitive munitions, energetic materials, ordnance, and propulsion.

High-Speed Weapons. High-speed supersonic and hypersonic weapons can provide dramatic improvements in platform and weapons survivability and in the ability to engage time-critical targets, and to penetrate hardened and deeply buried targets. WD has conducted extensive work in the enabling technologies required to make such weapons a reality, including efforts in advanced airbreathing propulsion systems, blended body airframes, high-temperature materials, and ordnance package concepts. Programs are under way to demonstrate these technologies in flight testing.



Biomimetics. WD is studying fly eyes and other insects as part of a new biomimetic technology initiative. The common fly has an amazing ability to find moving targets in cluttered backgrounds, and then to land on moving "platforms." WD wants to know how flies do it so scientists and engineers can improve imaging sensors and signal processing.

Digital Precision Strike Suite (DPSS). DPSS provides a brand-new capability for the Fleet. It is a self-contained laptop system that increases the success for first-pass attacks with smart weapons. The computer correlates real-time target images from various sensors with existing geographical database imagery and assigns a latitude, longitude, and elevation to any part of the target. These targeting data are then transmitted to the aircraft and weapon. And it's all done by one operator, using a laptop computer, in less than a minute. Already tested in operations in the field, DPSS revolutionizes strike warfare.

Spike. The weapon the front-line troops have been waiting for, Spike is a man-portable, fire-and-forget, guided missile and launcher system that is very low cost and lightweight (three missiles can be carried in a Marine's backpack). Highly effective against helicopters and lightly armored vehicles, Spike, will also be a boon to warfighters in urban-assault scenarios. Concepts are currently in development.

LOGIR. LOGIR is a low cost accuracy enhancement kit for existing rockets. LOGIR will do for rockets what JDAM did for iron bombs. The LOGIR project began in 2000 and is still under way. Its primary objective is to significantly improve the warfighter's ability to address moving and fixed targets with an emphasis on moving targets. LOGIR allows the warfighter to designate the target using the existing targeting FLIR. Once designated, the pilot can fire the rocket and leave the area. LOGIR will use the FLIR targeting data to fly to the target, and acquire and track the target to weapon impact. Concepts are currently in development.

JOINT SERVICE

Teamwork is the cornerstone of NAVAIR's success. Each and every activity that China Lake and Point Mugu participate in—every test event, training mission, and laboratory experiment—is a team effort. Teamwork binds together the network of highly trained scientific, technical, and administrative personnel (military, civilian, and contractor) who carry out the NAVAIR mission.

Teamwork extends far beyond the geographic and organizational borders of NAVAIR. Customers from throughout the Navy bring their problems to China Lake and Point Mugu, expecting and finding the solutions that help to make the Navy the central element of the national defense structure.

And teamwork reaches across service boundaries to the Marine Corps, Army, Air Force, Coast Guard, and Homeland Defense Department. NAVAIR is at the forefront of joint-service activity: joint training, joint testing, joint experimentation, joint research, joint development, and joint acquisition.

Among the many joint ventures on which China Lake and Point Mugu have embarked with the sister services is establishment of a Warfare Response Network and a Homeland Defense Response Team. NAVAIR's western-most bases have made major developmental, test, and training contributions to the Department of Defense's (DOD) top weapon systems. The Land Range, Sea Range, and Electronic Combat Range (ECR) have hosted virtually every combatant aircraft in the DOD inventory, ranging from Air Force fighters and bombers and Army helicopters to developmental aircraft (e.g., the F-22 and Joint Strike Fighter (JSF) to joint-service UAVs). Special Forces units have roamed the deserts hills of Superior Valley, and Marine light armored vehicles have raced across the dry flats of Airport Lake during live-fire exercises. The ranges and laboratories have played principal roles in the Nation's largest joint-service battle experiments, and Point Mugu has been selected as the site of the U.S. Joint Forces Command's Regional Joint National Training Center.

INTERNATIONAL SERVICE

The country's international partners benefit from the same principle of teamwork. The first Tomahawk firing from a British submarine took place on the Sea Range, and the Japanese Defense Force conducts annual training and missile-development exercises there. The Italian Air Force trains with HARM on the Land Range, and the Royal Danish Navy has participated in Evolved SeaSparrow Missile (ESSM) launches on the NAVAIR Ranges. Many countries send representatives to the F/A-18 AWL, and all North Atlantic Treaty Organization (NATO) countries benefit from NAVAIR-developed improvements to the Mk 82 series bombs. NAVAIR explosive ordnance disposal (EOD) units train with counterparts from Croatia to Thailand, and the Joint Tunnel Warfare Center welcomes representatives from the many U.S. allies in the worldwide war against terrorism.

Teamwork begins with the day-to-day business of the WD and its industry partners and extends through joint-service agreements and international collaborative efforts. It is a key element in guaranteeing that the fighting forces of the free world continue to be equipped with NAVAIR's finest products—weapons that win wars.

NATIONAL AND INTERNATIONAL FORUMS

WD has historically provided a leadership role in many professional societies. WD is on the Executive Committee of the Joint Army-Navy-NASA-Air Force Interagency Propulsion Committee (JANNAF); active in the American Institute of Aeronautics and Astronautics, and chaired the 2000 Missile Sciences Conference; serves on the Missile Sciences Committee; chairs sessions for the Military Sensor Symposia (MSS) on Active Systems, and the MSS National/International conferences; and co-chairs sessions for the National Fire Control Symposium. Internationally, WD is active in NATO and Technical Cooperation Program affairs, and chairs a panel on second generation military laser systems.

For more than 20 years, this group introduced and investigated new laser systems that have been successfully produced. During three years (1996, 1998, 2001) the group conducted highly successful field trials and generated high quality reports on laser performance under severe atmospheric turbulence. In 2002 this group won the NATO Research and Technology Organization scientific achievement award over a field of 150 other NATO groups. This work has had positive impact. For example, the joint Army/Navy Foreign Comparative Test program evaluated a German LADAR obstacle avoidance system for helicopters which is now in production for special operations command platforms. In addition, activities in 3-D imaging LADAR, support the Cruise Missile Real Time Retargeting program. WD also serves on the steering committee of the NATO Insensitive Munitions Information Center with representatives from the United Kingdom, Australia, and New Zealand. WD has also led several panels in propulsion, warheads, guidance, control, and fuzing.

TECHNOLOGY TRANSFER

The Federal Laboratory Consortium (FLC), the primary national Federal technology transfer group, consists of more than 700 federal laboratories and centers and their parent departments and agencies. The FLC, originally established by China Lake in 1971 as the DOD Technology Laboratory Consortium for Technology Transfer, grew from 11 original laboratories in 1971 to 200 laboratories in 1975 under China Lake leadership. The FLC promotes and strengthens technology transfer nationwide. Through the years, thousands of government patents have been awarded with numerous applications to warfighting systems, a key means of staying ahead of U.S. adversaries.

WD transfer programs have included telecommunications on radar systems, video frequency data conversions, data displays, test facilities, and a design for an airport firefighting system for short takeoff and landing airports for the Federal Aviation Administration (FAA). Work was done in low-light-level television, voice scramblers, patrol car tracking, and personnel communication links for the Law Enforcement Assistance Administration. Biomedical ideas have been brought to life for the National Institute of Health, and an air-quality-control monitoring program conducted mapping of aerosols for the State of California. Other significant WD contributions resulted from investigations into wind, solar, and geothermal energy; solid waste conversion to clean burning fuel; and aircraft survivability. An explosive device was developed to clear fire lines for the Forest Service.

CL-20. Most Significant Energetic Material In 50 Years. China Lake developed the most significant energetic ingredient in 50 years. CL-20 was a breakthrough in energetic materials with higher performance, minimum signature, and reduced-hazard characteristics. CL-20 has numerous military and commercial applications.

Automotive Air-Bag Sensors. A tiny micro-machined digital accelerometer designed by WD engineers as a guided-missile component is today at the heart of a life-saving system used throughout the world. In 1994, the Navy needed a means to accurately measure the distance traveled by the missile after launch—a computation necessary for arming the warhead-firing device at a safe distance from the launch aircraft. WD oversaw development of an accelerometer using microelectronic fabrication techniques. It was subsequently transitioned into millions of automobile crash-sensor air-bag-initiation systems by major foreign and domestic automobile manufacturers. The device, also used for hundreds of other consumer and industrial applications, is now marketed and sold internationally.

Geophysical Warfare "Rainmakers." During the Vietnam Conflict, U.S. warfighters needed a way to interdict enemy traffic on the Ho Chi Minh Trail. "Project Popeye" helped answer the call. China Lake adapted its cloud-seeding technologies to enhance rainfall, thereby significantly deterring enemy activity on the trail. This highly successful China Lake technology was also used in hurricane abatement, fog control, and drought relief.

Ultrasonic Scanning. During Vietnam, China Lake pioneered logarithmic amplifiers for radar signal processing applications. In 1971 this technology was transferred to the Mayo Clinic and led to the development of the first ultrasonic body scanning equipment.

Stop-Action Video. China Lake invented the electromechanical shuttered video camera to provide non-smeared stop-action images of weapon test events. Today, this technology is used for commercial stop-action sports broadcasting. Since WWII, China Lake has been one of the most accomplished developers of range instrumentation. Other examples include real-time continuous x-ray systems, high-speed photography, and encrypted telemetry.

Chemiluminescent Light Sticks. During the Vietnam Conflict, U.S. warfighters needed emergency lighting for life rafts, downed flyer beacons, map reading, and damage evaluation. China Lake scientists answered the call with a chemiluminescent light stick. Today this technology is used commercially worldwide for novelty items, commercial fishing lures, and illumination sticks for emergency kits.

Geothermal Energy. China Lake is practically energy independent. This world-class resource ranks among the top 10 in total power output. While California and much of the nation have been in an energy crisis, China Lake has remained nearly energy independent since 1987. In 1964, geological engineers at China Lake first discovered the enormous geothermal potential on the northwest portion of the base. In the 1980s, wells were drilled and contracts were established with Southern California Edison to tap this valuable resource. The Navy will save in excess of $500 million during the life of the contract. In addition, China Lake is the DOD lead laboratory for solar energy and has about one megawatt of photovoltaic (PV) systems installed, including the largest PV/diesel/battery hybrid in the world. The Energy Program Office has assisted with other PV installations for the Marines, Army, and Air Force.

Calcification-Prevention Tablets. Virtually every ship in the U.S. Navy today carries and uses a product invented by researchers at China Lake. For decades, the Navy dealt with the problem of calcium buildup in the sewer systems aboard ships. The traditional cure for pipes clogged by calcium deposits is expensive and time-consuming hydroblasting. China Lake scientists developed inexpensive, environmentally friendly, water-soluble polymers that are placed in the urinals in tablet form and release citric acid to bind the calcium in the flush water. More than 1.5 million tablets per year are used by the Navy and trouble calls on the high seas have dropped by 90%.

HazMat Containers. Point Mugu has also been actively involved in helping develop new technologies for hazardous materials containers. More than 60 different types of containers are now in use at Navy/Army/Air Force facilities around the world. They are also now available on commercial carriers.

Actuated Cable Cutters. In the early 1950s the Navy developed a blank, explosive, cartridge-actuated, cable cutter for emergency cable cutting for ship tow/transfer lines, helicopter supply lines, etc. In 1990, this technology transferred to private industry. Today, companies such as CACT CO and Hi-Shear Technologies, of Torrance, California, have developed advanced cartridge-actuated cutting tools that are used nationwide, as well as by many countries throughout the world by the police, sheriffs, SWAT teams, and fire departments, for cutting security bars, chains, and locks. These tools are also highly effective "jaws of life" for cutting through steering wheels and break pedals. The electric power line industry across the U. S. and in some foreign countries is now using cutters for cutting lines, bolts, and ground rods. These extremely portable devices are also indispensable for emergency relief during earthquakes, explosions, and other disasters. For example, in the Oklahoma bombing, cutters were used by the fire department to rescue trapped individuals.

PARTNERING WITH INDUSTRY AND ACADEMIA FLEET BENEFITS

Cooperative Research and Development Agreements (CRADAs). Since the early 1990s, the number of CRADAs at WD has continued to climb. Through 2003, WD has managed 155 CRADAs with industry partners that generated close to $17 million. The cumulative total cost avoidance value is estimated to be worth an additional $50 million; 19 new CRADAs were initiated in 2003 alone. Most agreements involve military-related technology.

Commercial Service Agreements (CSAs). WD has acquired and developed specialized equipment and many one-of-a-kind facilities. WD's resident scientists and engineers constitute a significant scientific resource. Legislation allows the government to offer access to industry and academia through CSAs. Outside entities may tap and leverage WD resources and knowledge by contracting to perform tests and develop specialized goods and services using WD facilities, ranges, and laboratories. During 2003 WD initiated 25 CSAs and received more than $6 million for support work covering a wide range of technical areas.

Patents With Commercial Potential. Since 1959, more than 1,500 patents have been issued at WD (1,051 at China Lake and 517 at Point Mugu). Some inventors hold more than 20 patents. During 2003 China Lake wrote 29 patent disclosures, 24 new patent applications, and 18 new patents were issued. Point Mugu wrote 26 patent disclosures, 19 new patent applications, and 19 new patents were issued.

Since the 1940s, scientists and engineers have created hundreds of inventions to solve technical problems associated with weapon development. The Web sites below include lists of patents that are licensable and those that have reverted to the public domain.

China Lake patents with commercial potential:
http://www.nawcwd.navy.mil/techtransfer/patentov.htm.
Point Mugu patents with commercial potential:
http://www.nawcwpns.navy.mil/~tt/Navy_patents.html.

ENVIRONMENTAL LEADERSHIP

From the stunning Native American rock art of China Lake's Coso Range to the rare Island Night Lizards of San Nicolas Island, WD's resources constitute an extraordinary national treasure. For more than 50 years, WD has exercised responsible, proactive stewardship.

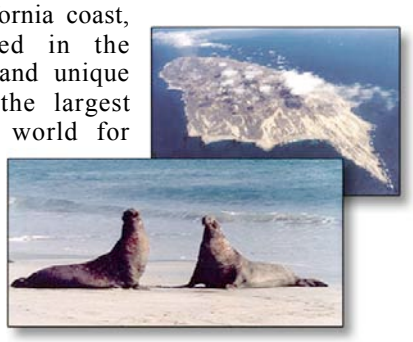
Unencroached With Room To Grow. Encroachment is a fact, to varying degrees, at all military installations. As the population grows, the issue naturally intensifies and many bases today are greatly affected by adjacent urban sprawl. However, of all DOD facilities, China Lake, located in a remote portion of the Mojave Desert, has the least potential to disturb the neighbors—more than one million acres, larger than the state of Rhode Island. Military activities impact less than 10% of the total land area. And the Sea Range, encompassing 36,000 square miles, is the Navy's largest test and evaluation facility. Business opportunities at WD have room to grow. In addition, WD is close to completing an Environmental Impact Statement (EIS) at China Lake. One EIS is already in place for the Sea Range. These studies will streamline the environmental approval process. WD RDT&E activities meet or exceed all state and federal clean air act, hazardous materials, and permitting requirements—opening the doors for new business.

Minimal 10% Impact. The vast majority of China Lake's land is a safety and security buffer and remains in a mostly pristine natural state. Locations for new facilities and specialized test events are carefully selected to minimize impact, and the staff scrutinizes virtually every mission-related activity to ensure that it complies with natural-resources laws and regulations. Ongoing formal cultural-resource inventories to identify archaeological, historical, and traditional properties have been conducted on more than 11,000 acres to date.

Dedicated Staff. Long-range resource planning, as well as day-to-day oversight, of scores of WD environmental projects, is carried out by a team of civil service professionals, ranging from archaeologists and ecologists to environmental engineers and augmented as needed by contract specialists. Community involvement is also encouraged. For example, the Friends of China Lake Archaeology, a self-help group of volunteers, logged more than 900 hours of work in the first half of 2003 to establish a federal curation facility on base.

Petrogylphs. China Lake protects the largest concentration of ancient rock art in the world. This area, 100 square miles of rugged mountain canyons inside the base boundaries, is a National Registered Historic Landmark. As a result of WD's unique stewardship, China Lake won the Governor's Award for Historic Preservation in 2003. Despite heightened security since the 2001 terrorist attacks, China Lake continues to provide public tours of the Coso petroglyphs.

San Nicolas Island. On WD's San Nicolas Island (SNI), 65 miles off the California coast, isolation has resulted in the evolution of distinct and unique taxa. The island is the largest breeding site in the world for California Sea Lions. Annually, more than 23,000 Elephant Seals, 100,000 California Sea Lions, and 500 Harbor Seals use the island beaches.



WD has recently broken ground on an approved $12 million-dollar military-construction project to build a special pier to meet operational requirements. In addition, the pier will keep boats from beach landings that could disturb sensitive wildlife. SNI also has an outstanding cultural heritage. The Nicoleno Indians inhabited the island for at least 10,000 years, and more than 500 archaeological sites have been documented. WD protects and preserves the resources at SNI in the context of an Integrated Natural Resources Management Plan.

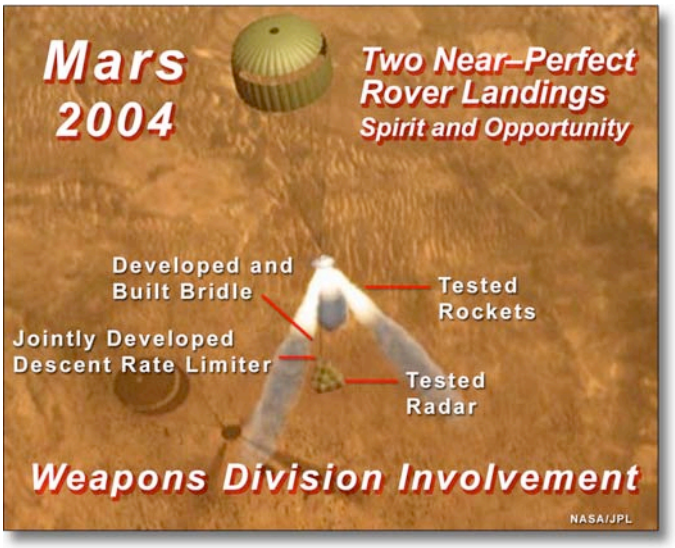
Management. During the last three years, WD developed aggressive management plans for preserving endangered species such as the Mojave Tui Chub, the Island Night Lizard, the Desert Tortoise, Mojave Ground Squirrel, the California Inyo Towheether, the Western Snowy Plover, California Brown Pelican, and the San Nicolas Island Fox. Plans protect birds from aircraft strike hazards, ravens from overpopulation, and pinnipeds from the impact of nearby missile launches.

Wild horses and burros, potentially at risk on runways, are rounded up annually and adopted out in a formal program in coordination with the Bureau of Land Management. China Lake cleared more than 100 acres of non-native vegetation that was depleting wildlife water sources and developed a Geographic Information System-based photographic database for identifying and protecting its 122 natural desert water sources.

Environmental Awards. In 2003 the Governor's Award for Historic Preservation was presented to China Lake for its long-standing heritage program that combines scientific, historic, recreation, and Native American values. No other military installation has been the recipient of such a prestigious award. In 2002, WD won the Chief of Naval Operations Environmental Award. The citation read in part, "Through your resourceful Natural Resource Program, you continue to effectively balance mission support with wildlife and land management through conservation education and conscientious environmental stewardship."

SPACE PROJECTS—FLEET BENEFITS

Mars Exploration Rover (MER) 2004



The Weapons Division provides direct Fleet support for Naval aviation. WD has extensive experience in developing, perfecting, and testing military components and subsystems that have direct application to space missions. Although work for other government agencies represents only a very small fraction of our total workload, the Division is occasionally called upon by NASA to lend expertise to projects of national importance. Lessons learned from joint projects are mutually beneficial. WD's experience includes rocket motors (deceleration and stabilization of spacecraft), jet vane and thrust vector control systems (precision guidance and landing control), and radar systems (determining distances from landing surfaces). Since 1979, China Lake has been home to the National Parachute Test Range (NPTR). Any Federal agency can take advantage of the unique combination of assets and technical skills at NPTR. For example, the Forestry Service (airborne fire fighters), Special Forces, Air Force, Army, and Marines have all tested on NPTR. WD has proven experience in parachute RDT&E (special cables, bridles, and tethers often used in space missions), and emergency escape systems (manned sea landing/recovery). WD maintains the Land Range, where technicians evaluate all types of Navy test equipment (as well as Lunar and Mars vehicles).

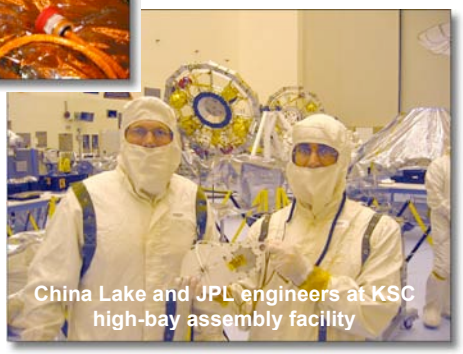
Fleet Benefits. WD's relationship with NASA is mutually beneficial. Lessons learned from joint projects help WD find solutions to Naval aviation problems. Lessons learned from the 2004 missions include developing the Zylon bridle that will allow increased deployment velocities and decreased weight and volume for future Naval aviation parachute systems. Zylon lines may one day replace heavy, cumbersome aircraft tie-downs on carrier decks. The radar altimeter may be considered for high-altitude, low opening (HALO) parachute systems. Also, the descent rate limiter is being considered for use in reusable reefing systems for Army cargo and Navy special forces parachute systems.

Mars Exploration Rover (MER) 2004. Continuing a 61-year relationship with the California Institute of Technology (Caltech) and a long-time relationship with NASA and the Jet Propulsion Laboratory (JPL, a division of Caltech), China Lake was asked to assist on the 2004 missions. (China Lake was established in 1943 as a place to test and evaluate Caltech rockets during World War II.) The success of *Spirit*, the Rover that landed on January 4, and *Opportunity*, that landed January 24, can be attributed in part to the innovation and technical expertise of China Lake's Egress and Survival Systems Division. The team has applied their extensive Navy parachute and egress expertise to assist NASA and JPL Mars missions for the past 10 years. The NAVAIR team accomplished the following tasks for the 2004 missions:

Zylon Bridle. China Lake designed, built, and assisted in the installation of the bridle system onto each spacecraft. The bridle connects the MER backshell to the Lander. Zylon, a new ultra-high-strength fiber, was subjected to strength and environmental testing, and the required joints were designed and tested. Prototypes were fabricated, qualification tests conducted, and finally three flight-quality units were fabricated at China Lake to support the two missions plus a "flight spare." Each bridle contained 22 digital communication wires, allowing each Lander to command the retro-rockets. The bridles worked perfectly and now remain on the surface of Mars.

Descent Rate Limiter (DRL). China Lake and JPL jointly developed the DRL. In addition, China Lake tested and qualified the mechanism, and installed it on each spacecraft at Cape Canaveral's Kennedy Space Center. The DRL allows the Lander to slowly drop to the end of the bridle. Initial tests were conducted at China Lake's Crew Systems drop tower, but results were unsatisfactory. Late in the program, JPL chose to abandon that design and, with China Lake's assistance, designed a totally new device. This design proved suitable, and several flight-quality units were qualified for use.


China Lake engineer installing DRL on Lander at the Kennedy Space Center


China Lake and JPL engineers at KSC high-bay assembly facility

Radar Systems. JPL adapted the radar altimeter from a Harpoon missile, and WD engineers built a test vehicle to deploy the radar system from a helicopter that made terrain-approaches over several types of geologic features. Then a series of drop tests was conducted to capture terrain-approach data at realistic speeds. The radar altimeter supplies the descending spacecraft with altitude and velocity data for use in timing airbag deployment and retro-rocket ignition.

Retro-Rocket Systems. WD conducted several motor-burn tests at its Weapons Survivability Laboratory. The flight-spare backshell was suspended from a test tower and restrained by the bridle. The retro-rockets were ignited to determine thrust and structural reactions. Follow-on tests were conducted with other motors to study and compensate for wind, proper separation of environmental covers, and inadvertent torque effects. Retro-rockets slow the Lander down from 200 mph until it hovers above the planet surface, ready for the airbag landing.


Retro-rocket testing at China Lake's Weapons Survivability Laboratory

Multi-Body Tests. Weapons Division tested the system. During descent, the parachute, backshell, and Lander are connected by lines and bridles into a three-body system. JPL was very interested in the dynamics that would result during the descent to Mars. So China Lake's Crew Systems built a simulated three-body test item and dropped it from a helicopter. On-board and ground-based instruments and video captured the response.

Six Minutes Of Terror. Entry, Descent, and Landing (EDL) on Mars requires perfect timing. More than half of all missions to Mars have failed. Landing entails getting a one-ton spacecraft traveling at 12,000 mph to safely stop within six nail-biting minutes. In the first four minutes, atmospheric friction slows the spacecraft to 1,000 mph and raises the temperature of the heat shield to about 2,600°F. With only 100 seconds left, a parachute slows the spacecraft to 200 mph; 20 seconds later, the heat shield is jettisoned, exposing the Lander inside; 10 seconds later, the backshell, still attached to the parachute, begins lowering the Lander on the bridle. A radar system then begins measuring altitude. Eight seconds before touchdown, gas generators inflate the Lander's airbags; two seconds later, the three main deceleration rockets on the backshell ignite, and one or two (of a set of three) small transverse rockets may be fired for stabilization if needed. Three seconds later, when the Lander is about 49 feet above ground, the bridle is cut and the Lander free-falls, cocooned in airbags, hitting the surface at 30 to 50 mph. The Lander then bounces as many as 30 times and rolls up to a mile before stopping. If it hits a sharp rock, the mission could be over—Mars is plagued with jagged boulders, massive craters, cliffs, and high winds.

Perfect Navigation and Control. After traveling more than 300 million miles for seven months, *Spirit* made a perfect landing. "My hat is off to the navigation team because they did a fantastic job of getting us right where we wanted to be," said Dr. Steve Squyres of Cornell University, Ithaca, N.Y., Principal Investigator for the science payload. "This is our new neighborhood. We wanted someplace where the wind had cleared off the rocks for us. What we're seeing is a section of surface that is remarkably devoid of big boulders, at least in our immediate vicinity." Three weeks later, *Opportunity,* an identical twin to *Spirit,* also made a near-perfect landing halfway around the planet from where *Spirit* landed. JPL's Pete Theisinger, project manager for the rovers said, "We are two for two." And Dr. Steve Squyres, proclaimed, "We have scored a 300-million mile interplanetary hole in one." WD tested the rocket motors that helped ensure both of these precision landings. In addition, WD engineers were part of the team that evaluated the landing performance of *Spirit* in preparation for the *Opportunity* landing.

JPL, NASA, Navy, Industry Partners. According to Dr. Charles Elachi, director of NASA's JPL, President George W. Bush called to congratulate the MER flight team for reconfirming the American spirit of exploration, stating that "…We have assembled the best team of young women and men this country can put together." In addition, people from around the world share a special connection to this mission. The Landers each carry a DVD containing millions of names collected during a "Send Your Name to Mars" campaign. Images from this mission have the highest-resolution, more than three times that of the 1997 Mars Pathfinder. Only two weeks after the landing, NASA's Web portal received two billion hits, and users downloaded 154 million Web pages worldwide.


Spacecraft separation test at China Lake's MESA facility

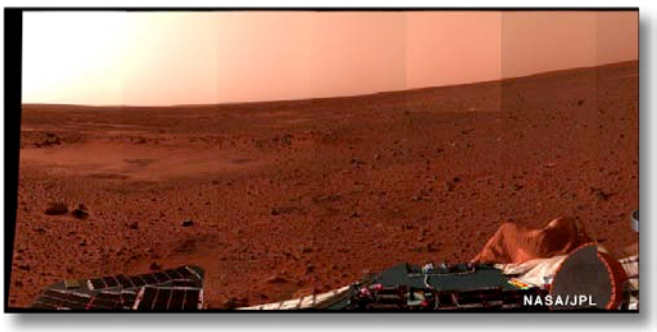
Initial activities are also under way for developing a lander dynamics test facility at China Lake in support of JPL's Mars Science Laboratory (MSL) program. The MSL is to be the first of a new generation of smart landers capable of exploring hazardous locations on Mars. The next mission is planned for 2009.


White House Photo Eric Draper

"Congratulations for reconfirming the American spirit of exploration."

—President George W. Bush

Movies/Animation. Additional information is available from JPL at http://marsrovers.jpl.nasa.gov; from Cornell University at http://athena.cornell.edu; and from NASA at http://marsrovers.nasa.gov. Numerous animations clearly illustrate the mission, see: Entry, Descent, and Landing (EDL).


NASA/JPL

SPACE PROJECTS (HISTORICAL)

NASA Support. During 2000, the China Lake Supersonic Naval Ordnance Research Track (SNORT) facility conducted "fly-by" tests propelling a prototype, laser-based hazard avoidance system for use on future Mars smart-landers. In 2000 and 2001, China Lake evaluated technology for a system to anchor a spacecraft to the surface of a comet, evaluated the feasibility of firing prototype canisters into a variety of terrains for a Mars mission, and performed tests on space shuttle bail-out systems. China Lake works with NASA, and other services, on the Integrated High Payoff Rocket Propulsion Technology, the goal of which is to double rocket propulsion performance by 2010. Early projects have included developing a parachute system for the Galileo Atmospheric Probe in the 1980s, testing the parachute for the Space Shuttle solid rocket boosters, designing and evaluating an emergency-escape system for the Space Shuttle, and testing a rocket-assisted deceleration (RAD) system for Pathfinder. China Lake fabricated the RAD-landing package tether system that was used in the successful Pathfinder landing on Mars in 1997.

NOTSNIK—One Of The First U.S. Satellites. In August 1957, Soviet Premier Nikita Khruschev announced the launching of a long-distance multistage intercontinental ballistic missile. According to Khruschev, the Soviet Union could now "direct missiles into any part of the world," and the Soviets demonstrated their superiority by launching Sputnik, the earth's first manmade satellite. Many American rocket experts predicted that the U.S. was "facing a technological Pearl Harbor." In response to this challenge, China Lake's NOTSNIK team made six attempts to launch a China Lake-designed and -built missile and payload into orbit. Flying over the Sea Range at Point Mugu, the pilot gained as much speed as possible at an altitude of about 40,000 feet, and then pulled up into a steep climb. When he reached an altitude of about 70,000 feet, he launched NOTSNIK. The aircraft was unstable at that altitude and the engine would flame out. Five of these tests clearly failed. However, the failure—or success—of the third orbital try is still a subject of debate. According to Dr. John Nicolaides, former Technical Director of the Navy's Space Program in the Bureau of Ordnance in Washington, D.C., the third NOTSNIK did enter orbit.

Navy Astronautics Group. The Navy Astronautics Group, with headquarters at Point Mugu, was commissioned in 1962 to operate the Navy Navigational Satellite System (NNSS), known as TRANSIT, that permitted Fleet units to fix their precise positions at sea, day or night, in any kind of weather. In 1963, the destroyer *USS Hazelwood* was the first Navy vessel to test a then-secret navigation system that received data from an orbiting satellite.

Shortly thereafter, the system was made operational for use with the Polaris ballistic missile submarines and aircraft carriers.

In 1967, the Government authorized manufacture of commercial versions of the shipboard navigation sets and sale to non-military interests. Applications included oil exploration, mapmaking, world-wide commercial shipping, and as a universal time standard. System accuracy was emphasized during rendezvous and recovery operations in connection with astronauts returning from Apollo expeditions to the moon. The navigation satellites were launched into 600-mile circular polar orbits from Vandenberg AFB. They orbit the Earth every 107 minutes, transmitting a message every two minutes describing where they were in space. The Navy had tracking and injection stations in Maine, Minnesota, on Laguna Peak at Point Mugu, and in Hawaii. Point Mugu managed the entire system.

TRANSIT operations continued until 1996 when the new GPS technology became operational. In 1990, the original astronautics group was formally redesignated the Naval Satellite Operations Center (NAVSOC), under the guidance of the Naval Network and Space Operations Command. Today, NAVSOC maintains the six remaining TRANSIT satellites, but they have also greatly expanded their mission and operations to include multiple satellite operations, and they now have additional detachments in Guam, and Colorado.

RAPID PROTOTYPING FOR QUICK-FIX FLEET SOLUTIONS

The Fleet Support Initiative (FSI) is an effort to identify small, quick-fix problems at the working level in the Fleet and to find a solution. Another key function is to build NAVAIR participation in the Office of Naval Research (ONR) Tech Solutions process, established to receive and respond to Fleet requests. The concept is to focus and communicate actively with Sailors and Marines to determine what went wrong on their last deployment and what future capabilities are needed.

One of the goals is to identify and select tasks that can be accomplished in a year or less. Among the FSI projects are efforts to provide a low-cost "Link-16" for legacy platforms, a thermal-imaging maritime surveillance system, a small, lightweight night-vision device for aircrew survival vests, and a night-vision goggle-compatible flashlight. Several of these simple, inexpensive solutions can make the difference in whether or not an aircraft or the lives of aircrew survive an emergency. Tech Solution requests for support, include improved helo ballistic protection, line-of-sight communications, covert ejection seat beacons, and portable solar panels.

Since the Vietnam War, China Lake and Point Mugu have participated in the Vietnam Laboratory Assistance Program (VLAP) and the subsequent Navy Science Assistance Program (NSAP), providing quick, low-cost, solutions to important Fleet problems throughout the world. NSAP is now the ONR Naval Fleet Force Technology Innovation Office.

WD Fleet Weapon Support Teams (FWSTs) also provide on-site technical and training assistance to operational forces worldwide. For the war on terrorism, WD has outfitted unmanned aerial vehicles (UAVs) with specialized sensors and instrumentation required for Coast Guard and Homeland Defense missions. WD has accelerated periscope radar development to increase submarine safety in littoral waters, and is developing special tunnel-warfare weapons and technology, as well as Spike, a low-cost guided missile that fits neatly in a Marine/Navy Seal commando backpack.

WD has historically provided customized direct support for special warfare systems. Examples include nonirritating face paint sticks, night-vision devices, map illuminators, liquid explosives, small personal identification beacons, hand-emplaced fuel-air explosion (FAE) canisters for mine clearance, lightweight gun pods, a lead-computing gun sight for aircraft, luminous wristwatch dials, auto-inflatable life preservers, 20-mm gun pods, and the Limpet Assembly Modular (LAM) swimmer-emplaced mine.

WD also provides direct support to the Special Operations Forces with custom explosives, grenades, specialized weapons, communications gear, air and ground reconnaissance technology, thin-pack parachutes, portable targeting systems, and other unique support equipment.

NAVAIR

Weapons Division

China Lake, CA • Point Mugu, CA

Who We Are – What We Do

Mission. To provide our armed forces with effective and affordable integrated warfare systems and life-cycle support to ensure battlespace dominance.

- Perform research, development, test, and evaluation (RDT&E), logistics, and in-service support for guided missiles, free-fall weapons, targets, support equipment, crew systems, and electronic warfare.
- Integrate weapons and avionics on tactical aircraft.
- Operate the Navy's western land and sea range test and evaluation complex.
- Develop and apply new technology to ensure battlespace dominance.

- Free world's leader in RDT&E of guided missiles, advanced weapons, and weapon systems. Proven through 50 years of unparalleled products.
- World leader in complex weapon systems and software integration.
- World leader in energetic materials and subsystems.
- Developed the Sidewinder missile—the world's premiere dog-fight weapon. Sold to 31 countries.
- Unique world class facilities and test ranges for weapon system solutions for the warfighter.
- Finest weather in the world for testing. 360 clear days per year.

Enormous unencroached land, sea, and airspace:

- 1.1 million acres (larger than the state of Rhode Island)
- 36,000 square miles of sea range off the Southern California coast, including San Nicolas Island.
- R-2508 restricted airspace encompasses 12% of California's total airspace. Jointly managed with Edwards AFB and Fort Irwin.
- Few areas in the world offer such a wide variety of geographical features in close proximity—mountains, ocean, deep water ports, protected islands, deserts, canyons, and forests.

Major Products and Services

Missiles and Free-Fall Weapons

AMRAAM, HARM, Harpoon, Hellfire, JDAM, JSOW, Penguin, Phoenix, RAM, Sidewinder, SeaSparrow, SLAM, SLAM-ER, Standard Missile, Tomahawk, VLA.

Weapon System Integration

All Navy and Marine Corps tactical aircraft, including the F/A-18, F-14, AV-8B, EA-6B, EP-3E, AH-1, JSF, and the F-22 (Air Force).

Electronic Warfare

AN/AAR-47 Warning System; AN/ALE-29, -39, -47, -50 Countermeasures Systems; AN/ALR-66, -67 Warning Systems; Infrared Countermeasures; Integrated Defense Electronic Countermeasures.

Research, Development, Test, and Evaluation

- Engineering/logistics for tactical missiles and free-fall weapons
- T&E of weapons, weapon components, and integrated weapons systems in realistic environments
- National Parachute Test Range
- Full-scale joint-live-fire survivability testing
- Explosives and propellants RDT&E from laboratory samples up to 500,000 pounds
- Network Centric Warfare; interoperability
- Modeling and simulation
- Basic and applied research, science, and technology
- Full-scale and sub-scale targets

Fleet Preparedness Training

Fleet training and tactics development, including major exercises on the Sea Range, Land Range, Superior Valley, and Electronic Combat Range.

Scope of Operations (FY03)

Revenue $1.01 billion
Contracts (all supplies and services) $421,000,000
Personnel (As of March 1, 2004)
- Civil Service: 4,251
- Military: 507
- Contractors: 2,224
- Total: 6,982

Size
- Number of acres: 1.1 million
- Square miles of restricted airspace over land: 17,000
- Square miles of restricted airspace over sea: 36,000
  - Test area expandable to: 125,000

Facilities
- Buildings: >3,000
- Major facilities: 40. Airfields: 2.
- Plant replacement value: $2.8 billion

Annual Test Events 3,100
Training Sorties 1,400
Major Training Exercises 30

Partnering Opportunities. DoD, other agencies, academia, and industry. Cooperative Research and Development Agreements, Commercial Service Agreements, Navy Potential Contractor Program and Patent License Agreements.

Customers (Partial List)

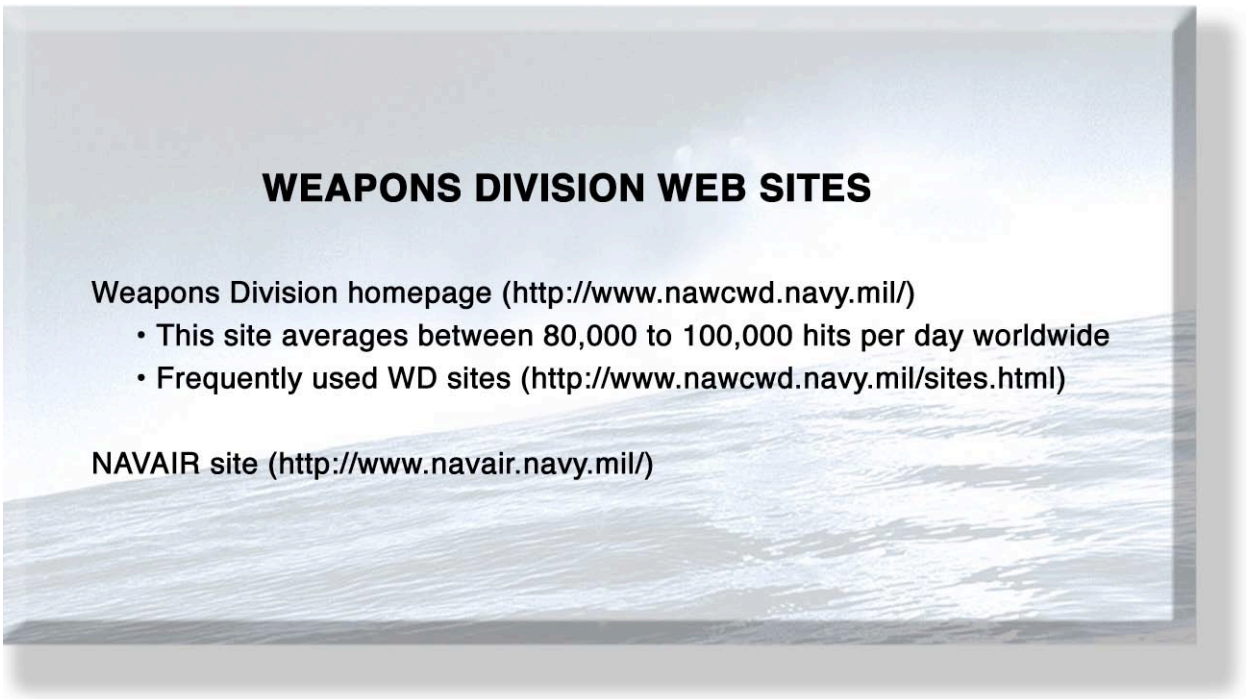
Major Programs. F/A-18, AV-8B, F-14, Sidewinder, HARM, EA-6B, AH-1, TACAIR EW, Standard Missile, Tomahawk, JSOW, EP-3E, Harpoon, SLAM, RAM, JDAM, TAMPS, JMPS, AMRAAM, RAM, SLAM-ER, Trident, Sparrow, Patriot, F-22, V-22, ESSM, Hellfire, JASSM, NACES, T-45, Fleet Battle Experiments, Naval Fires Network, VLA, GCCS-M, JSIPS-N.

Government. ONR, NAVSEA, SPAWAR, Special Forces, USAF, Army, NASA, FBI, FAA, Dept. of Transportation, NRO, NIMA, DARPA, DTRA, NTSB, Missile Defense Agency.

Foreign. Japan, Australia, Canada, Germany, Israel, Spain, Switzerland, Taiwan, UK, France, Norway, Italy.

Major Industry. Boeing, Lockheed Martin, Raytheon, Northrop-Grumman, General Atomics, BAE Systems.

Looking to the Future
- Network Centric Warfare
- Energetics
- High Speed Weapons
- Unmanned Aviation
- Homeland Defense – Counter Terrorism



Naval Air Systems Command

NAVAIR delivers weapon systems to warriors for Navy and Marine Corps missions. Our products and services include fixed and rotary wing aircraft, avionics, air- and surface-launched weapons, electronic warfare systems, cruise missiles, unmanned aerial vehicles, launch and arresting gear, and training systems. NAVAIR provides total life cycle support of our products: research, design, development, and engineering; acquisition; test and evaluation; repair and modification; and in-service engineering and logistics support.

NAVAIR encompasses eight sites across the country. The Weapons Division is located at China Lake and Point Mugu, California. NAVAIR Aircraft Division has sites at Patuxent River Maryland; Lakehurst, New Jersey; and Orlando, Florida. NAVAIR depots are located at North Island, California; Jacksonville, Florida; and Cherry Point, North Carolina.

NAVAIR has approximately 32,000 military and civilian employees; manages approximately 150 acquisition programs; and maintains more than 4,100 aircraft in active inventory, including 96 individual type/model/series. Principal customers include the operating forces of the Navy and Marine Corps, joint programs of the U.S. Department of Defense, other activities of the U.S. Armed Forces, and foreign allies.

NAVAIR is comprised of six organizations working as a fully integrated team: Naval Air Systems Command (NAVAIR); Naval Inventory Control Point (NAVICP); Program Executive Office, Air Anti-Submarine Warfare, Assault, and Special Mission Programs (PEO(A)); Program Executive Office, Tactical Aircraft Programs (PEO(T)); Program Executive Office, Strike Weapons and Unmanned Aviation (PEO(W)); and Program Executive Office, Joint Strike Fighter (PEO(JSF)).

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